Paper Plane Pilot

No. A-281
Instructional Computing Courseware
for Apple® II Series Computers

A product from the
Science Inquiry
Collection

for the love of learning

mecc

This manual is compatible

with

the ***Paper Plane Pilot*** disk

Version 1.x

© MECC
6160 Summit Drive North
Minneapolis, Minnesota 55430-4003

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Library of Congress Cataloging-in-Publication Data

Paper plane pilot [computer file]. — Version 1.0.

1 computer disk ; 3 1/2 in. + 1 manual. — (Science inquiry collection)

System requirements: Apple II series computers; 128K RAM; ProDOS; BASIC; 1 disk drive; monochrome or color monitor; supports networking with other computers.

Title from title screen.

Edition statement from disk label.

Copy-protected.

Audience: Grades 3-6, junior high.

Issued also on 5 1/4 in. computer disk.

Summary: Challenges students to determine how each of the four variables—plane shape, plane weight, launch angle, and launch force—affect the distance a paper airplane will travel. Students test planes by using different combinations of the variables, and observe and record their results.

"A-281" — Disk label.

1. Aerodynamics—Juvenile software. 2.Paper airplanes—Juvenile software. [1. Aerodynamics—Software. 2. Paper airplanes—Software.] I. Minnesota Educational Computing Corporation. II. Series.

TL570 1991 629.132 91-13294

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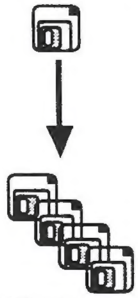

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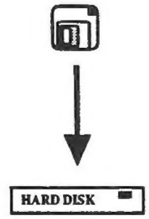

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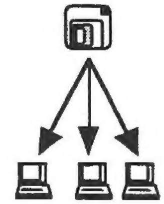

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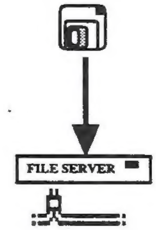

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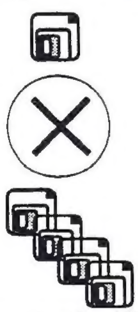		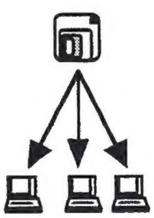	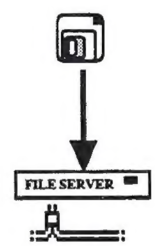
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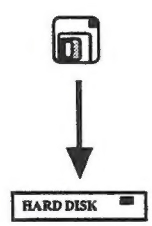

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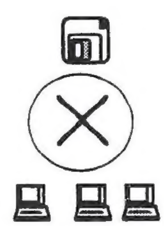

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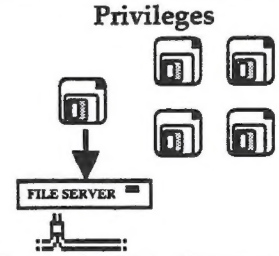

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AN OVERVIEW OF MECC'S *SCIENCE INQUIRY COLLECTION*

The MECC *Science Inquiry Collection* is a set of software packages specially designed for elementary and junior high science students. Each package covers a specialized topic in the physical, earth, or life science curriculum areas. All of the packages in the *Science Inquiry Collection* promote student achievement in elementary science by:

- emphasizing the science process skills of observing, communicating, comparing, organizing, and relating;
- using instructional objectives that correlate to the objectives addressed in popular science textbooks;
- presenting flexible material that can be used in a variety of educational environments;
- using instructional approaches that promote active student involvement and investigative learning;
- providing students with an open and creative environment in which they may develop and apply their problem-solving skills;
- encouraging students to freely share their discoveries and compare and explore various problem-solving techniques; and
- presenting instructional materials and learning experiences that can readily be transferred to concrete, hands-on classroom activities.

Each disk in the *Science Inquiry Collection* contains Teacher Options that allow the programs to be modified to meet specific classroom needs. *Science Inquiry Collection* products present material in a process-oriented manner. Each package includes an open-ended exploratory program that allows students to collect, organize, and interpret data, and form and test models. In addition, each package has a "challenge" program that presents students with a problem or challenge they must complete, using the information they gathered in the exploratory program. The courseware packages described in the following chart compose the current *Science Inquiry Collection*.

AN OVERVIEW OF MECC'S *SCIENCE INQUIRY COLLECTION* (continued)

Products currently included in the *Science Inquiry Collection* are briefly described below.

	Grade Levels	Topic
Physical Science		
* **Miner's Cave**	3-6, Jr. High	Simple Machines
* **Mystery Matter**	3-6, Jr. High	Properties of Matter
Mystery Objects	2-4	Properties of Objects
* **Paper Plane Pilot**	3-6, Jr. High	Force and Motion
* **Wood Car Rally**	3-6, Jr. High	Force and Motion
* **Woolly Bounce**	K-2	Force and Motion
Life Science		
* **Backyard Birds**	3-6, Jr. High	Bird Identification
Cavity Busters	3-6, Jr. High	Population Changes
Cleanwater Detectives	3-6, Jr. High	Water Pollution
* **Invisible Bugs**	3-6, Jr. High	Genetics
* **Lunar Greenhouse**	3-6, Jr. High	Plant Growth
* **Weeds to Trees**	3-6, Jr. High	Plant Succession
Earth Science		
Five-Star Forecast	4-6, Jr. High	Weather Forecasting
* **Fossil Hunter**	3-6, Jr. High	Fossil Identification
* **Murphy's Minerals**	3-6, Jr. High	Mineral Identification
* **Sun and Seasons**	3-6, Jr. High	Seasonal Changes

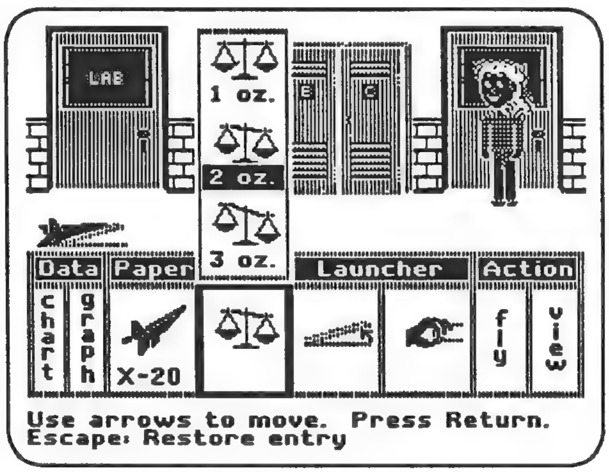
* Award-winners

INTRODUCTION

Paper Plane Pilot is a discovery-learning simulation that capitalizes on the natural curiosity of students and encourages them to use their curiosity while developing appropriate scientific processes and learning scientific content.

Paper Plane Pilot is part of MECC's *Science Inquiry Collection.* Like all the packages in this collection, ***Paper Plane Pilot*** features a strong process orientation while presenting material that is firmly anchored in the elementary and junior high school curriculum.

In ***Paper Plane Pilot*** students are challenged to determine how each of the four variables—plane shape, plane weight, launch angle, and launch force—affect the distance a paper airplane will travel. Students make this determination by testing planes with various combinations of the variables. As the planes are tested, students observe and record their results. The information collected enables students to determine how each characteristic affects the distance a paper plane will fly.



The physical science concepts addressed by, or related to, ***Paper Plane Pilot*** include:

- motion and the laws of motion;
- forces; and
- gravity.

The science process skills developed by ***Paper Plane Pilot*** include:

- observing;
- communicating;
- inferring;
- comparing;
- organizing;
- relating;
- designing and experimenting; and
- estimating.

INTRODUCTION (continued)

In ***Paper Plane Pilot***, students set out to determine the impact of each of the four variables on the distance a paper airplane will fly. Like actual scientists, students can design experiments to test the influence of each variable. The variables are represented by an icon and displayed in a menu bar on the screen (Figure 1). Students choose from several different conditions for each variable.

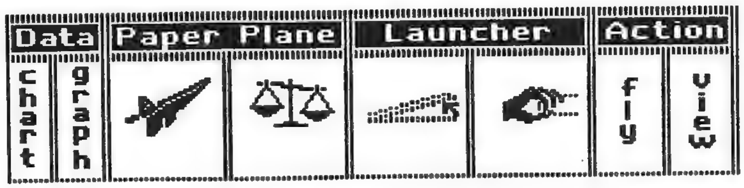


Figure 1

THE PRODUCT AT A GLANCE

Description

Paper Plane Pilot is a discovery-learning simulation that allows students to test the influence of each of four variables on the distance a paper airplane will fly. Students use the information they collect to predict the distance a plane will travel under a given set of conditions. ***Paper Plane Pilot*** includes two instructional programs. **Practice Flight** enables students to explore the relationships among the variables in an undirected, open-ended environment. The knowledge and understanding that students gain from **Practice Flight** is applied in the second program, **Challenge Flight**. In order to be successful in **Challenge Flight**, students must select a set of variables that results in a paper plane flying a given distance. To increase the challenge, one of the variables has been pre-set. Students can choose their challenge from three levels of difficulty.

Title:	***Paper Plane Pilot***
Subject Area:	Physical Science
Topic:	Force and Motion
Processes:	Observing, comparing, classifying
Program Type:	Discovery-learning simulation
Classroom Use:	Individual students or small groups
Sound:	Sound may be turned on or off during the programs by pressing Control-S whenever the computer is waiting for a response
Exiting Programs:	Students may leave a program by pressing the Escape (Esc) Key whenever the computer is waiting for a response

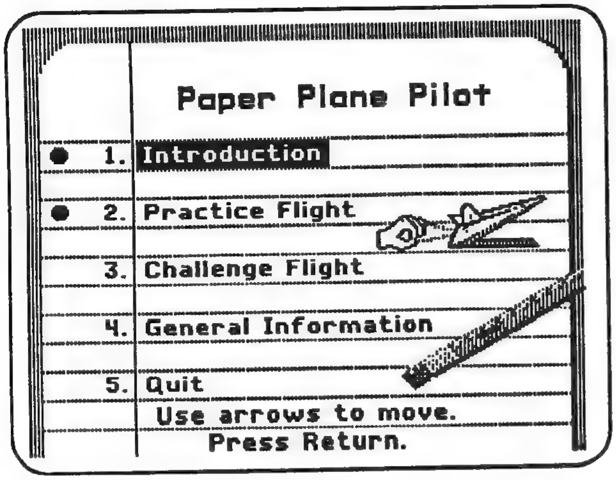
LEARNING OBJECTIVES

Using this courseware, students will practice:

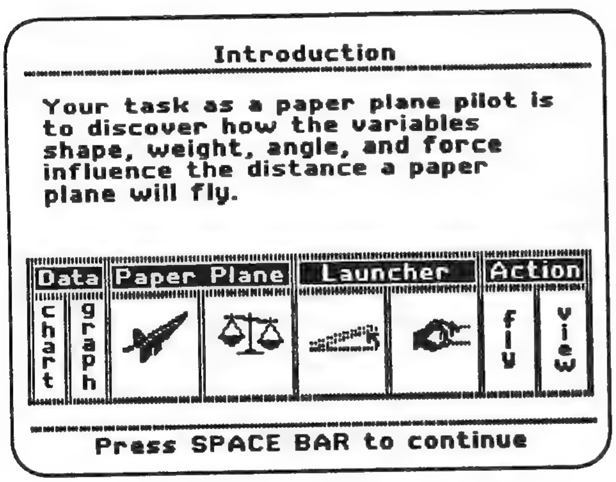
- controlling four variables to observe their effect on the distance a paper airplane will travel;
- observing, hypothesizing, forming and testing models, and designing experiments; and
- collecting, organizing, and interpreting data in order to solve a problem.

PROGRAM PREVIEW

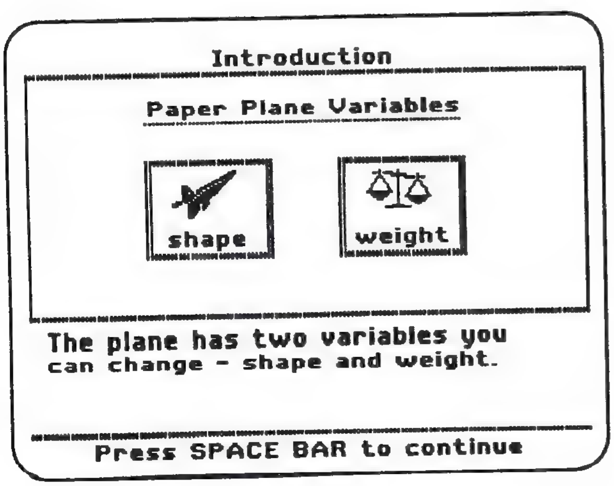
Introduction



Before running **Practice Flight** or **Challenge Flight**, select **Introduction** from the main menu to learn about ***Paper Plane Pilot***. To select a program from the main menu, use the Arrow Keys to move the cursor, or press the appropriate number key, and then press the Return Key.



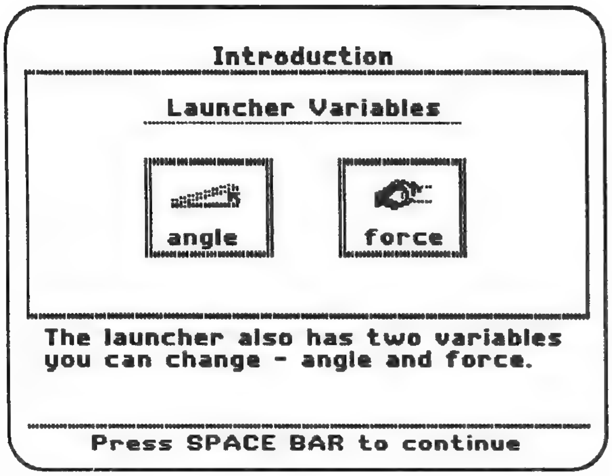
Selecting **Introduction** takes you to a series of screens that describe ***Paper Plane Pilot***. The first screen, displayed here, informs you that your task is to discover how four variables influence the distance a paper plane will fly.



The **Introduction** screens also identify the various options found on the ***Paper Plane Pilot*** menu bar. These include the four variables for the paper plane and the launcher. As shown in this screen, the paper plane variables are shape and weight.

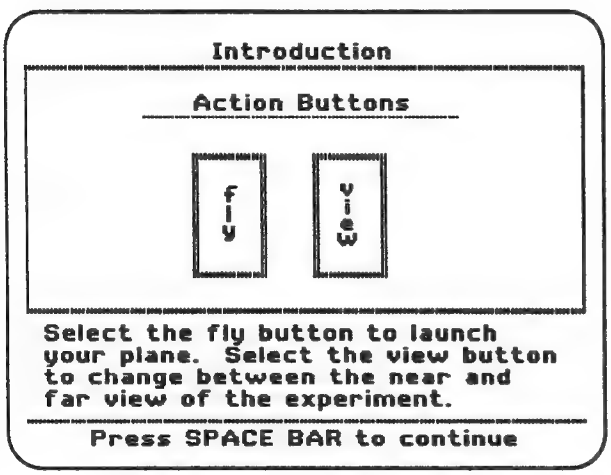
PROGRAM PREVIEW (continued)

Introduction (continued)

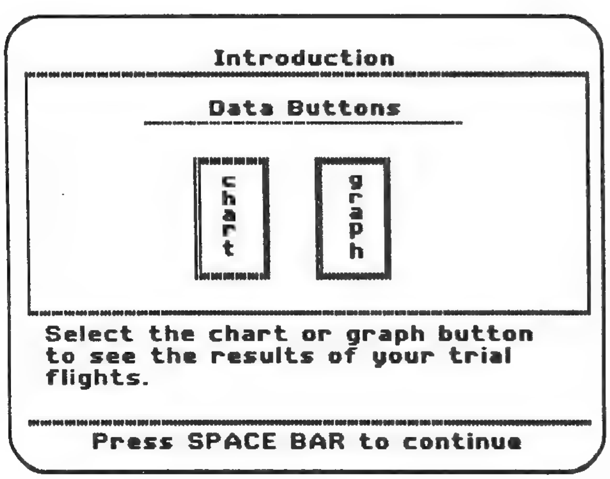


The two launcher variables are angle and force.

You can change the four variables as often as you want; however, it is good scientific procedure to change only one variable for each trial. You are encouraged to carefully test and think about your results in order to discover how each variable affects the distance your paper plane will fly.

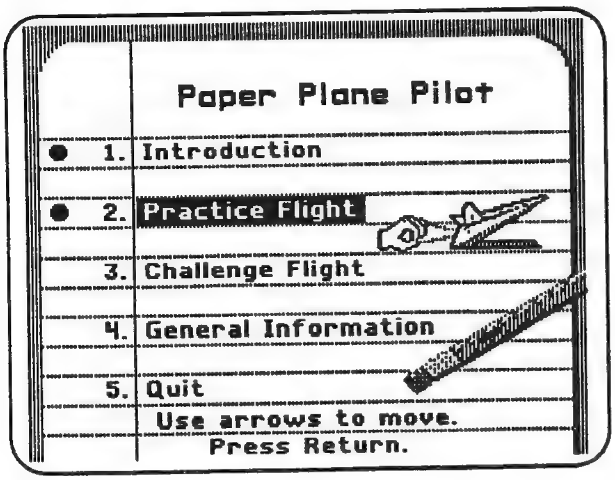


The two action buttons are fly and view. The view button may be selected before or after a flight. Selecting the view button will switch between a close-up and a full view of the scene. The close-up view screen represents 1/3 of the maximum flight distance. The full view screen represents the entire maximum flight distance.

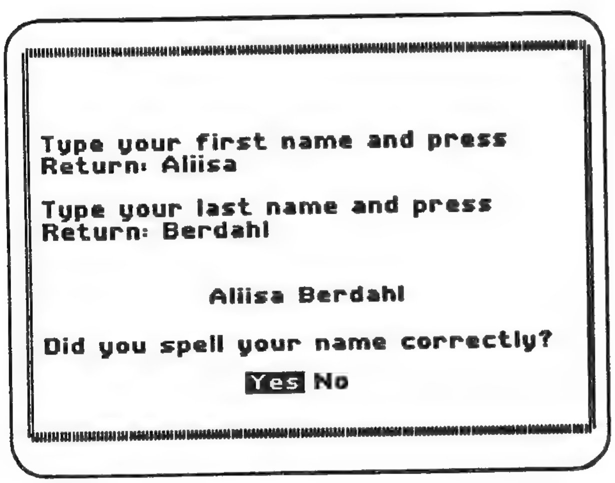


The data buttons are chart and graph. The settings and results for each trial are automatically recorded and presented in chart or graph form.

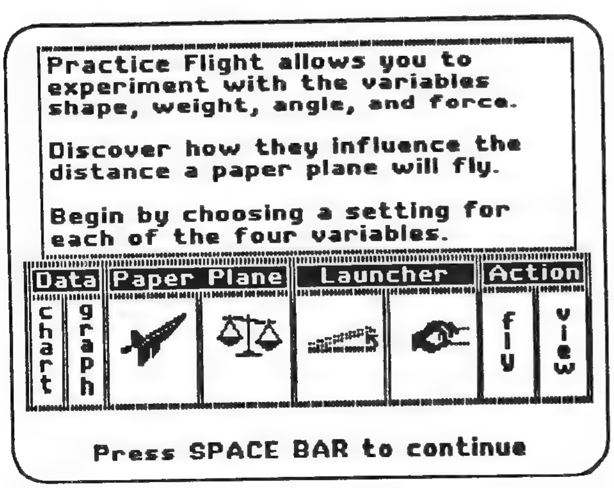
Practice Flight



After running the **Introduction**, begin ***Paper Plane Pilot*** by choosing Option 2, **Practice Flight**, from the main menu.

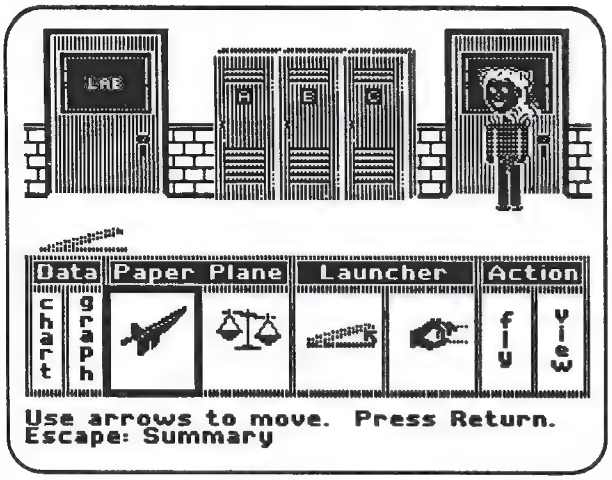


Before beginning, you must enter your first and last names for record-keeping purposes.

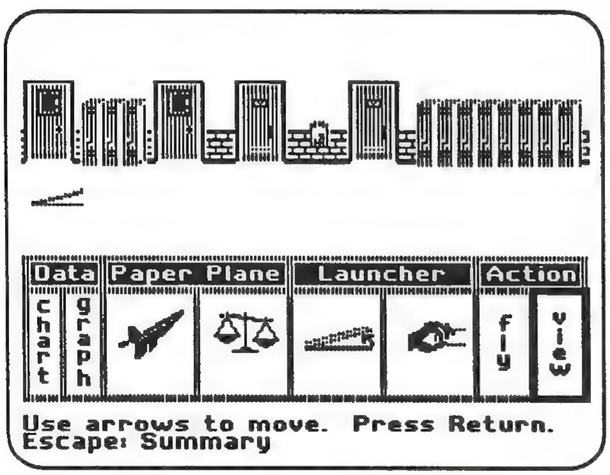


Practice Flight is an open-ended program that allows you to experiment with the variables of shape, weight, angle, and force. Your goal is to determine the effect the variables have on the distance a paper plane will fly. There is no limit on the number of trials you may run. If, however, you run more than 250 trials during one session, a new record will be started in Student Records (see page 17).

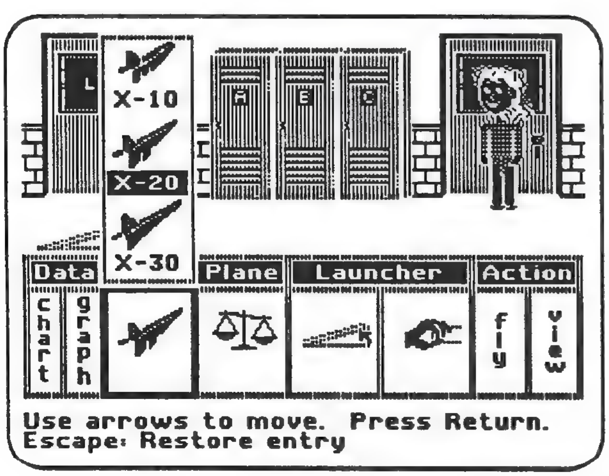
Practice Flight (continued)



In *Paper Plane Pilot*, you carry out experiments in the hallways of a school. You first enter **Practice Flight** with a close-up view showing one section of the hallway. The maximum paper plane flight distance requires three sections of hallway, which are shown on three consecutive screens.



Selecting the view action button will take you to a full view of the hallway, which shows the entire distance the plane could fly. (This is equivalent to the three consecutive screens on the close-up view.) Selecting the view button again will return you to the close-up view of the hallway.

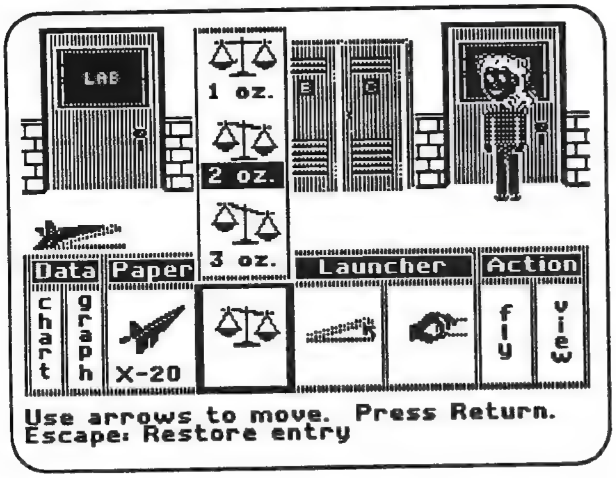


When you first enter **Practice Flight**, none of the variables are set. You must set each variable shown on the menu bar before you can launch the plane.

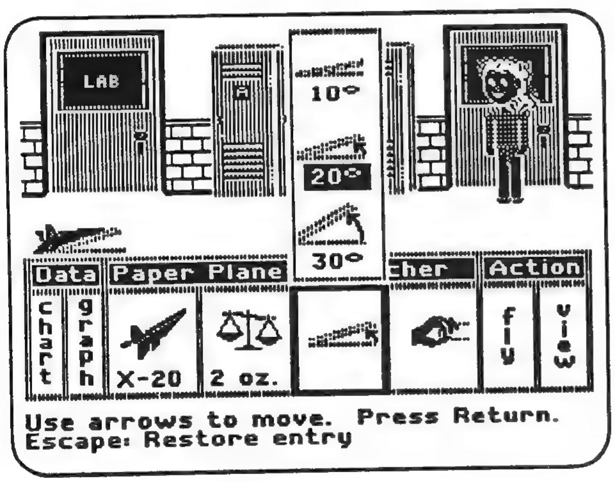
To set a variable, use the Arrow Keys to move the cursor to the desired variable. Press the Return Key to get a pop-up menu of available settings. Use the Arrow Keys and press Return to make a selection in the pop-up menu. The selection you made will appear beneath that variable icon in the menu bar.

This screen shows the three setting choices for the shape of the paper plane.

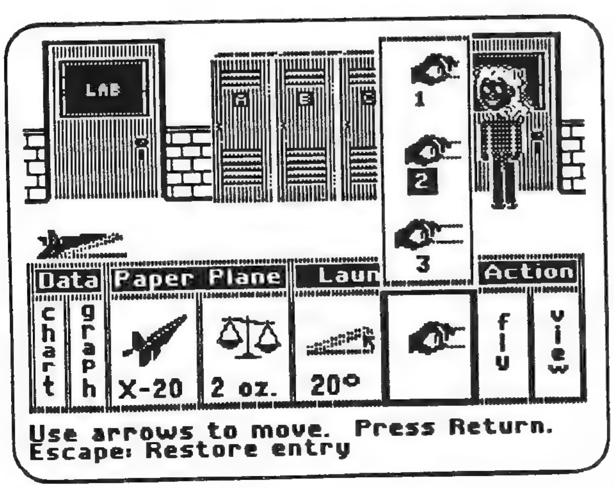
Practice Flight (continued)



This screen shows the three setting choices for the paper plane weight. The Teacher Options setting will determine whether the weights appear as ounces or grams (see page 16).



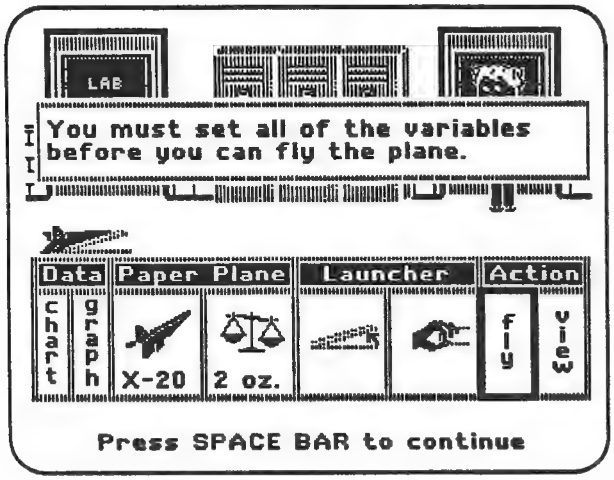
This screen shows the three setting choices for the launcher angle.



This screen shows the three setting choices for the launcher force. Think of creating a force by pulling back on a rubber band.

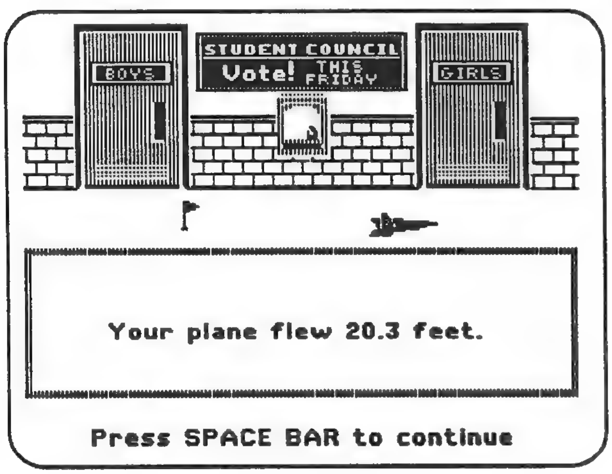
PROGRAM PREVIEW (continued)

Practice Flight (continued)



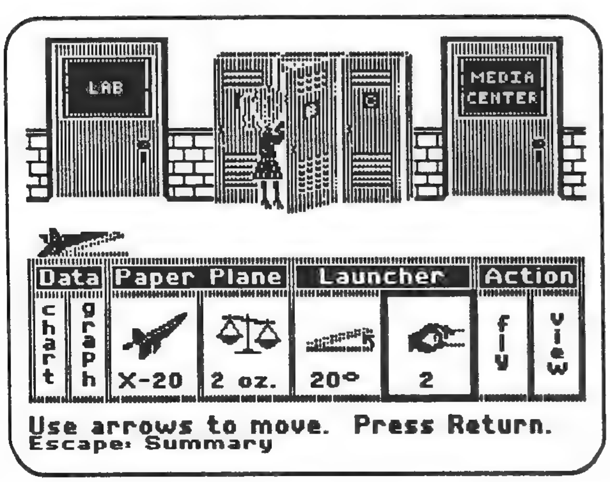
Once all four of the variables have been set, you may select the fly-action button to launch the plane.

If the fly-action button is selected before all of the variables have been set, a message will tell you that you must set all of the variables before you can fly the plane.



The distance the plane flies is determined by the variable settings. When the plane lands, a message gives you the distance the plane traveled.

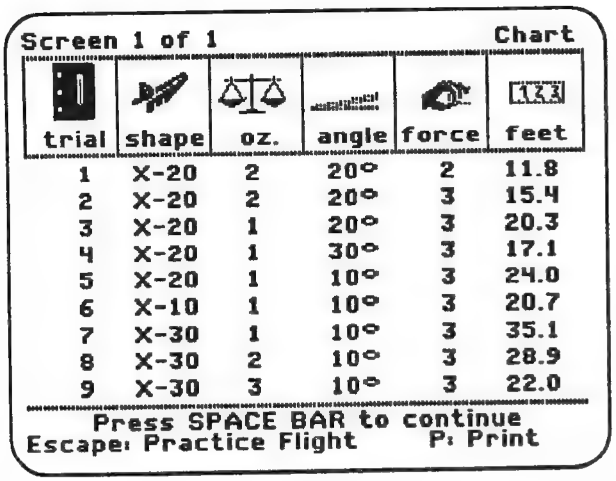
At times you will see a marker flag on the screen. This flag marks the landing point of the previous flight. The flag helps you compare the current trial to the performance of the previous flight.



At the completion of each flight your plane is returned to the launcher. You may see the data of all completed trials in chart or graph form or change variable settings and run a new trial.

If the chart or graph button is selected before a trial flight has been completed, a message will tell you that no data has been collected yet.

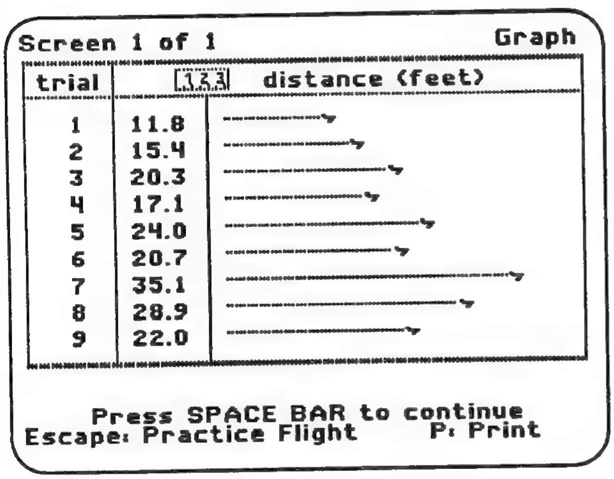
Practice Flight (continued)



trial	shape	oz.	angle	force	feet
1	X-20	2	20°	2	11.8
2	X-20	2	20°	3	15.4
3	X-20	1	20°	3	20.3
4	X-20	1	30°	3	17.1
5	X-20	1	10°	3	24.0
6	X-10	1	10°	3	20.7
7	X-30	1	10°	3	35.1
8	X-30	2	10°	3	28.9
9	X-30	3	10°	3	22.0

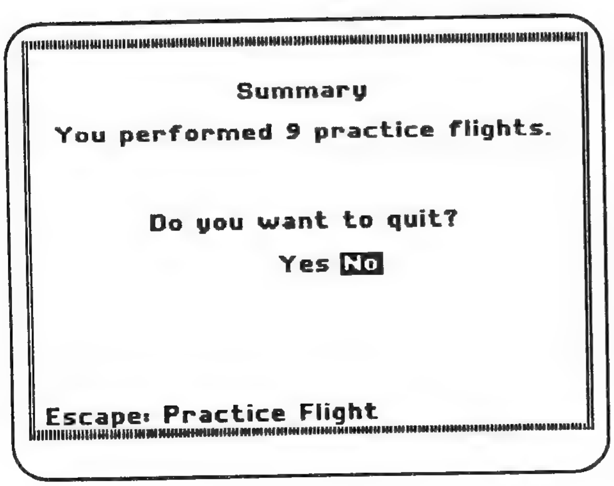
Selecting "chart" from the menu presents the data for up to 50 completed trials in a chart format. The data kept for each trial includes plane shape, plane weight, launcher angle, launcher force, and distance traveled. Each chart screen will show data for nine trials.

The chart may be printed if Teacher Options are set to allow student printing (see page 16). If printing is not allowed, the P: Print command will not appear on the screen.



Selecting "graph" from the menu presents the distances traveled in a horizontal bar graph. The graph will track distances for up to 50 trials (nine trials per screen).

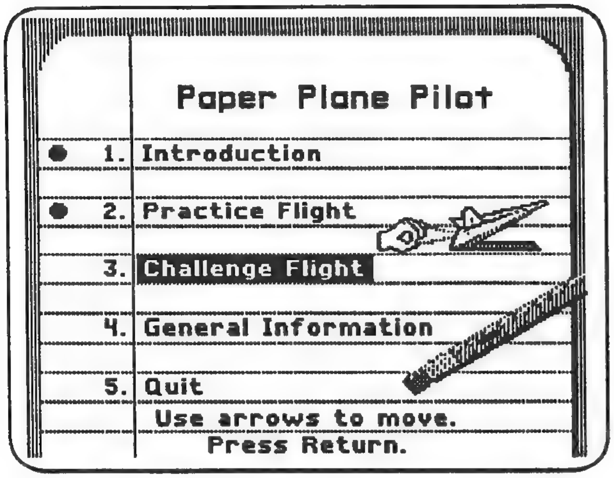
The graph may be printed if Teacher Options are set to allow student printing (see page 16). If printing is not allowed, the P: Print command will not appear on the screen.



Pressing the Escape Key allows you to quit **Practice Flight** and brings you to a summary screen. This summary tells you how many trials you have completed and makes sure you want to quit.

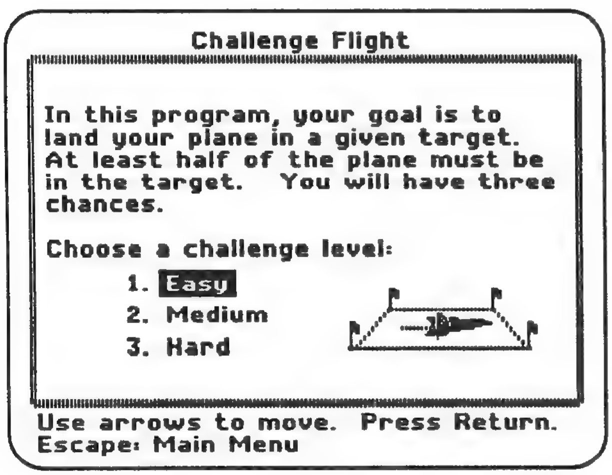
PROGRAM PREVIEW (continued)

Challenge Flight



Once you are familiar with **Practice Flight**, select Option 3, **Challenge Flight**, from the main menu.

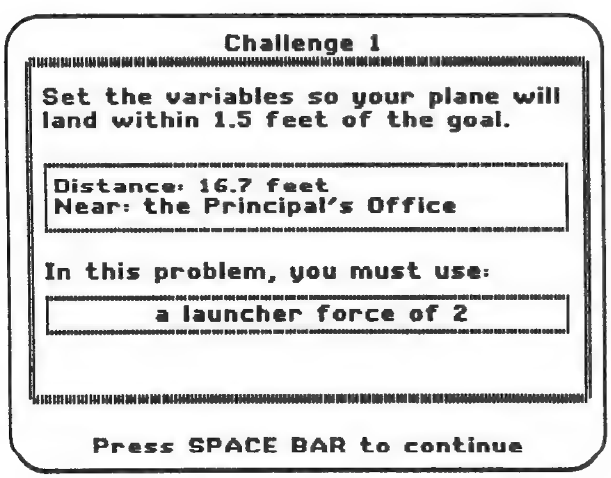
Challenge Flight operates in the same manner as **Practice Flight**. In **Challenge Flight**, however, your goal is to land your plane within a given target.



In **Challenge Flight**, you may choose from three challenge levels. As the levels get harder, targets get smaller. For each level, you must be within a certain distance of the goal.

Easy level: 2.5 feet or 0.75 meters
Medium level: 2.0 feet or 0.60 meters
Hard level: 1.5 feet or 0.45 meters

You will have three chances to set the variables so that your plane will land within the target.



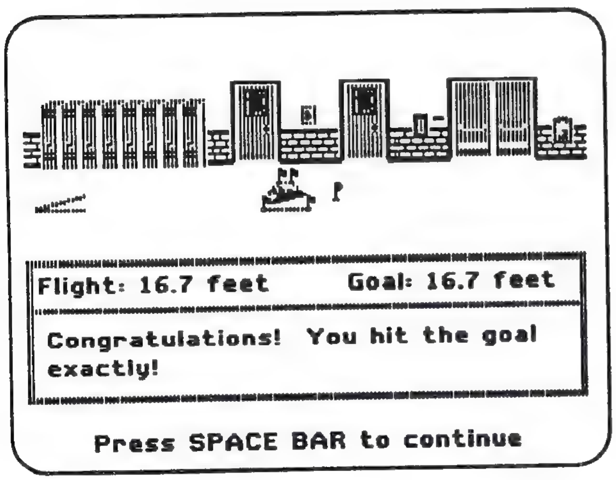
Once you select a level, you will receive your challenge. Your goal is identified by a given distance and landmark. For each challenge problem, one of the four variables is pre-set.

Challenge Flight (continued)

You first enter **Challenge Flight** with a distant view of the hallway. This view allows you to locate the goal and target.

The goal distance is shown at the top of the screen.

You set the variables for the plane and launcher in the same manner you set them for **Practice Flight** trials (see pages 9-10).



The distance the plane flies is determined by the variable settings. If at least half of your plane lands in the target, you are considered successful.

The distance your plane traveled will always be shown along with the distance of the actual goal.

If your plane lands within the target, you will receive on-screen congratulations.

PROGRAM PREVIEW (continued)

Challenge Flight (continued)

If your plane does not land within the target, the plane will be returned to the launcher so you may change variables and try again. You may view the chart and graph to review settings and results for two **Challenge Flight** attempts. You have three chances to land the plane in the target.

Challenge Flight

	Easy	Medium	Hard
Number right	2	2	6
Number tried	2	2	8

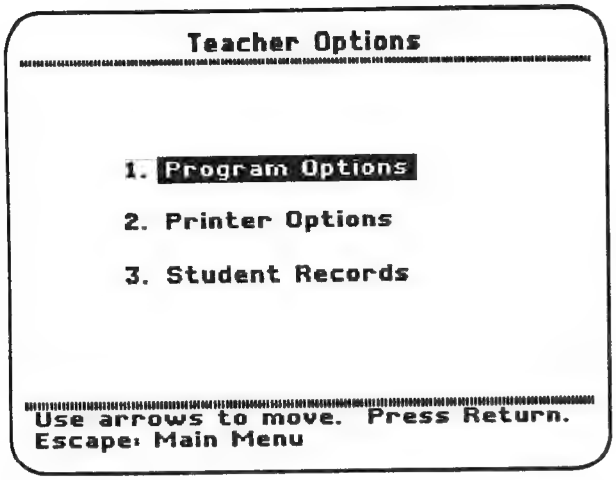
1. Try another problem
2. Change levels
3. Return to Main Menu

Use arrows to move. Press Return.
Escape: Main Menu

At the end of each challenge problem, you see the summary that outlines the number of problems tried and solved for each level.

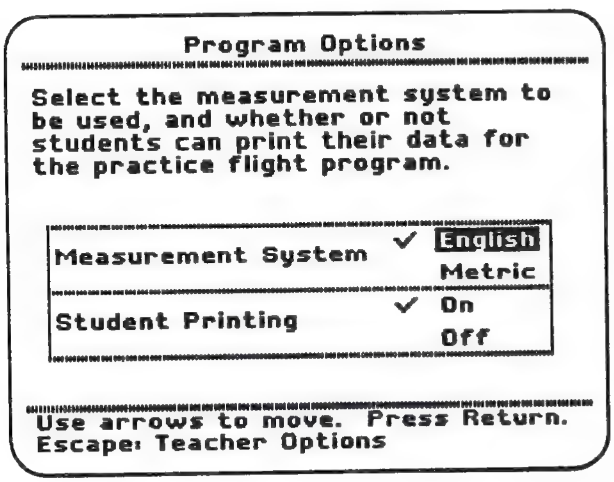
At this point you may choose to try another problem, change levels, or return to the main menu.

TEACHER OPTIONS



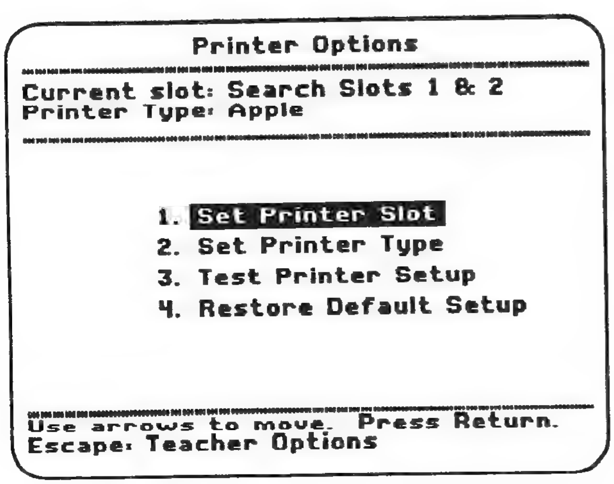
Accessing Teacher Options

Paper Plane Pilot contains three Teacher Options that can be accessed from the main menu by pressing Control-A (hold down the Control Key and press the letter A). This screen shows the Teacher Options menu.



Option 1: Program Options

This option enables you to determine the measurement system to be used in the program and whether or not printing will be available. If the printer is turned off, students will not be able to print their data. The checkmarks indicate the current program settings.



Option 2: Printer Options

This option is provided in order to accommodate the use of a printer with this product. *Paper Plane Pilot* is initially set to work with a standard Apple printer card located in either Slot 1 or Slot 2. If you have this setup, you do not need to use this option to make any changes. For detailed instructions on using this option, refer to the section "Using a Printer with This Courseware" (pages 57-59).

TEACHER OPTIONS (continued)

```
                Student Records

This disk stores records for 75
sessions. When this limit is
reached, the oldest record is
deleted as each new record is saved.

28 records are currently saved.

     1. See student records
     2. Print all student records
     3. Erase all student records

Use arrows to move.  Press Return.
Escape: Teacher Options
```

Option 3: Student Records

The disk can store up to 75 student records. Once the file is filled, the program will automatically start erasing the oldest records as new records are saved. This option allows you to see, print, and erase student records.

Screen 1 of 2

Name	Level	Result
Berdahl, Aliisa	P	17
Hanson, Sarah	C1	2/3
Munson, Justin	C3	3/4
Hanson, Sarah	P	10
Munson, Justin	P	11
Fortney, Zachary	P	29
Hanson, Sarah	C2	2/3
Nagelhout, Paula	C3	0/2
Nagelhout, Paula	C1	1/1
Nagelhout, Paula	P	12
Munson, Justin	P	18
Berdahl, Aliisa	C3	6/8
Berdahl, Aliisa	C2	2/2
Berdahl, Aliisa	C1	2/2

```
Arrow Keys: More Records     P: Print
Escape: Student Records      ?: Help
```

The first column on the student records screen displays the student's name. Symbols in the "Level" column indicate the skill level the student used:

P = Practice Flight
C1 = Challenge Flight (Easy)
C2 = Challenge Flight (Medium)
C3 = Challenge Flight (Hard)

Numbers in the "Result" column indicate student achievement in the program. For the Practice level, the whole number indicates the number of trials run. For the Challenge levels, the fraction indicates the number of problems solved out of the number of problems attempted.

USE IN AN INSTRUCTIONAL SETTING

This section describes the overall instructional approach of ***Paper Plane Pilot*** and provides additional information related to using the program in an educational setting. Information on the effective use of ***Paper Plane Pilot*** is divided into five sections: Preparation, Using the Programs, Student Strategies, Additional Classroom Activities, and Lab Activities.

Paper Plane Pilot is designed to be used in conjunction with a textbook chapter and/or other classroom activities on force and motion, and the variables that affect them. It can be used at the beginning of the unit to introduce the topic or at the conclusion to reinforce the important topics.

The strength of this instructional software lies in the manner in which it is used in the classroom environment. The overall emphasis of ***Paper Plane Pilot*** is on presenting students with a problem-solving simulation that promotes discovery learning. The program directly supports and complements actual hands-on experimentation in the classroom. As a teacher, you can choose to present the concepts by using the computer, by conducting hands-on experiments, or by using a combination of these two methods. The supportive and complementary nature of ***Paper Plane Pilot*** gives you the opportunity to create a powerful and flexible instructional environment.

Several methods for classroom implementation of the program are mentioned below. These ideas represent suggestions. The actual selection and sequencing of activities remains up to you so that you can tailor the instruction to meet the needs of your students. In a similar manner, how much direction you give to your students depends on their own skill levels. Some students benefit from a teacher-directed approach while others function best when allowed to explore and develop their own strategies.

Preparation

Although primarily designed for students in grades 3-6, students of many age levels may use ***Paper Plane Pilot***. Since many of the concepts introduced in ***Paper Plane Pilot*** are presented in junior high school science classes, you may want to use ***Paper Plane Pilot*** to introduce concepts to junior high school physical science students. Very little "scientific" terminology has been used in these programs, with the exception of the word "variable" and the phrase "scientific procedure." You may choose to introduce these terms to younger students before using ***Paper Plane Pilot***.

Students new to ***Paper Plane Pilot*** may benefit from a short demonstration of the program. The **Introduction** and the program **Practice Flight** may be used for classroom demonstrations. Several handouts are included to be used as part of an introduction to ***Paper Plane Pilot*** for your students (pages 25-35). Student Handout 1 introduces and explains the function of each of the four variable symbols, while Handout 2 reinforces those same functions in a matching format.

Using the Programs

Encourage your students to keep a record of the variable selections and the results of each trial attempted during their investigations in both **Practice Flight** and **Competition Flight**. Students may record the information as they are making choices or copy the information from the review chart at a later time. Student Handouts 3-6 are designed to allow students to record their trial runs in both chart and graph form. Student Handout 7 will help students summarize information they learn from ***Paper Plane Pilot***. Keeping accurate records is especially important if you do not have a printer connected to the computers or if you have elected to turn off the printer option.

Student Strategies

As a discovery-learning simulation, ***Paper Plane Pilot*** provides students with an open environment for experimenting with and developing successful problem-solving strategies. Students may exhibit a wide variety of approaches to the problem of learning how to control the distance a plane will travel.

Common successful strategies include the following:

- Some students prefer to work in cooperative groups or pairs. In many instances, these students tend to be more successful, or at least successful sooner, than students who tend to work alone.

- Students often attempt to determine the conditions that will make the plane fly the longest or shortest distance. After discovering how to achieve these results, they think that they understand the relationships between the variables and the result. In **Challenge Flight**, however, it will become evident that they do not understand the relationships well enough to control the plane in most of the intermediate distances. These students should be encouraged to explore additional variable combinations in **Practice Flight**.

Although individual student approaches vary greatly, each type of successful approach commonly features information collection, careful and complete record-keeping, comparison, and analysis. Some students may not readily develop a successful strategy. Classroom discussions can, however, encourage students to share both successful and unsuccessful strategies.

Classroom Activities

Several additional classroom activities can be used to complement and strengthen the instructional objectives and processes presented by ***Paper Plane Pilot***. In many cases, the activities listed in this section are designed to be used immediately after students use ***Paper Plane Pilot***. Some activities, however, can also be used as introductory lessons. Others can become long-term classroom activities. The selection and order of the activities depends upon your specific classroom environment.

The true value of these activities lies in the ideas, comments, and questions that arise from discussing the experience. During and after using ***Paper Plane Pilot*** and the additional activities, allow sufficient time for students to share their observations, approaches, and findings. This interaction can be encouraged by having students work together in cooperative pairs and by informing them that discussion sessions will follow the activity.

Discussion Sessions

Engage your students in a discussion of their findings, using such questions as: What is a variable? What were the variables in this investigation? Did all four variables affect the distance the plane flew? Did all the variables have the same effect? Encourage your students to describe their findings and explain their successful strategies.

Interdisciplinary and Extension Activities

- Have students illustrate and write about the concepts they've investigated.
- Encourage your students to create a scrapbook with pictures of different types of airplanes, famous aviators, or other flight-related objects.
- Invite guests to speak to your students about how these concepts are used in some careers and hobbies. Invite a pilot or a radio-controlled model-plane enthusiast to speak with your class.
- Take your students on a field trip to an airport or an aviation museum.
- Celebrate Aviation History month in November. Let students select those people from aviation history, such as Ameila Earhart or Charles Lindbergh, whom they'd have most liked to have flown with and then write short essays giving their reasons. Have students share their essays with the class.
- As a classroom or individual project, construct planes from a kit, plan, or personal design. Plans for paper planes can be found on the Lab Activity Handouts (see pages 36-46).
- Invent a paper plane game. For example, let students set up a target in the gymnasium and see who can construct planes that can hit the target.

Interdisciplinary and Extension Activities (continued)

- Encourage students to give an oral report comparing a bird, a kite, and a balloon with an airplane.
- Help students prepare a timetable of the men and women who have contributed to the history of air and space travel.
- Create wind in the classroom with an electric fan. Make a paper plane and explore what happens when you launch the plane with the wind, against the wind, or across the wind.

THINKING SKILLS

Using MECC Science Products to Reinforce Core Thinking Skills

The MECC *Science Inquiry Collection* products have as their primary goal to provide an environment in which students can learn and reinforce the use of science inquiry or science process skills. This set of skills includes observing, collecting or recording data, organizing data, analyzing data, forming hypotheses or predictions, constructing models, and testing models. The purpose of the scientific method is to provide an organized process of approaching problematic situations and determining solutions.

Each step in the inquiry process is, of course, related to and supported by a web of core thinking skills. A good science observer also displays good focusing skills, information gathering skills, remembering skills, and so on. A good scientist is, therefore, skilled at both appropriate scientific techniques and appropriate thinking skills.

Even though they share some terminology, the science-inquiry process specifically relates to what science is and what a scientist does. Core thinking skills are life skills necessary for the well-being of everyone in every situation. One can possess science-inquiry skills and be a poor scientist because one has poor thinking skills. Alternatively, having good thinking skills alone does not make one a good scientist. Therefore, science inquiry skills and core thinking skills, though closely intertwined, really present the teacher with two quite different sets of teaching objectives.

While the primary goal of the MECC *Science Inquiry Collection* products is to highlight and reinforce science inquiry skills, the rich environment each product presents is also well-suited to fostering good thinking skills. As a result, these products can easily be adapted by teachers in any subject area to highlight and to reinforce core thinking skills as outlined on the following pages.

When teaching thinking skills with these science products, please keep in mind that, although only one example of the use of a particular thinking skill is correlated to a particular part or use of a program, the same skills can be practiced on many levels and in many aspects of these programs.

Using Computer Software in a Thinking Skills Environment

Teachers are faced with the tremendous task of preparing today's students for tomorrow's world—a world characterized by change in an information-rich environment. Thinking skills are at the heart of this thriving, changing environment, for these are the behaviors students must practice in school and continue to apply for the rest of their lives.

It wasn't long ago that thinking skills were considered exclusive to gifted and enrichment classes. Today, however, thinking skills are viewed as an essential component of the total school curriculum. Developing these skills is the goal of each individual discipline. Many educators have, in fact, come to view thinking skills as perhaps the most basic of the basic skills because they facilitate the acquisition of all other learning.

At MECC, we view computer software as a vehicle for fostering students' thinking. Our products are curriculum-based, with thinking skills as a thread within subject areas. This provides an environment with many opportunities for teachers to highlight and reinforce thinking skills.

We believe teachers play a critical role in determining the classroom environment for thinking. Naturally, many teachers have taught thinking skills and will continue to do so using a variety of strategies. Our commitment is to provide teachers with the materials that help them do their job well: high-quality software that promotes the application of thinking skills.

Our approach to thinking skills reflects what both research and effective classroom practice has shown. That is, the approach that is most effective and appeals to most teachers is one that infuses thinking skills into existing content areas. Educators have told us they are interested in thinking skills as a method used in the instruction of a topic, not as a subject. By infusing thinking skills into existing content areas, MECC products integrate easily into teachers' curricula while providing a rich environment for students to practice skillful thinking. We strive to meet the challenge teachers face in promoting the skills that students need.

If schools are to integrate the teaching of thinking with regular academic instruction, they need to know what aspects of thinking to teach. After exploring the research that has been done in the area of thinking skills, MECC has chosen as a base the *Dimensions of Thinking* framework, published in 1988 by the Association of Supervision and Curriculum Development (ASCD). We chose this framework because it pulls together research and models from a variety of sources and brings the theory to the classroom level, applying it to that environment. In addition to knowing the subject matter that is covered, teachers now can see the specific thinking skills that are challenged within a product.

This section highlights ways in which teachers can use ***Paper Plane Pilot*** to promote thinking skills with their students. The following pages provide examples of how ***Paper Plane Pilot*** relates to the ASCD core thinking skills framework. Although only one thinking skill per category is correlated to a specific part of the product, each skill can be practiced on many levels and in many aspects of the product.

We realize the importance of thinking skills in the curriculum. We believe it is essential that students be taught thinking skills so that they have the tools to understand the past, deal with the present, and prepare for the future. We are confident that you will find ***Paper Plane Pilot*** of considerable value in your classroom as you foster student thinking.

A Framework for Thinking

The components used in thinking are referred to as *core thinking skills*. This framework defines those skills that appear in the repertoire of the model learner. Each skill selected is documented in research as important to learning or thinking, is teachable, and is valued by educators as important for students to learn.

The core skills of the ASCD framework are listed and defined below with examples of applications within ***Paper Plane Pilot***. The skills are neither discrete nor hierarchical. In fact, individual skills draw on other skills and can be used repeatedly in the thinking process. The selected examples are not exhaustive but highlight ways in which these thinking skills are used in ***Paper Plane Pilot***.

Source: Dimensions of Thinking, Association for Supervision and Curriculum Development (ASCD), 1988.

Definition of Core Thinking Skills Categories	Core Thinking Skills Components	*Paper Plane Pilot* Application
Focusing Skills allow students to attend to selected pieces of information and ignore others. Focusing occurs when students sense a problem, an issue, or a lack of meaning.	**Focusing Skills** • Defining Problems • Setting Goals	In ***Paper Plane Pilot,*** students discover how the variables of shape, weight, angle, and force affect the distance a paper plane will travel.
Information Gathering Skills involve obtaining information and clarifying issues and meanings through inquiry.	**Information Gathering Skills** • Observing • Formulating Questions	As students design experiments controlling the variables, they must carefully observe how the variables affect the flight of the paper plane. This information, coupled with record-keeping, will enable them to predict flight distances for a given set of variables.
Remembering Skills are those activities or strategies that students consciously engage in to store and retrieve information from long-term memory. Activating prior knowledge falls under this category.	**Remembering Skills** • Encoding • Recalling	Students gather and analyze information looking for predictable patterns among the variables. Success in the program **Challenge Flight** depends on a knowledge and understanding of the patterns they discover.

Definition of Core Thinking Skills Categories	Core Thinking Skills Components	*Paper Plane Pilot* Application
Organizing Skills are used to arrange information so that it can be understood or presented more effectively.	**Organizing Skills** • Comparing • Classifying • Ordering • Representing	As students adjust the four variables in their investigations, they compile and organize the results. They can view this information in chart or graph form. Or they may chart and graph the information themselves using handouts provided in this manual.
Analyzing Skills are used to clarify existing information by examining parts and relationships. Through analysis, students identify and distinguish components, attributes, claims, assumptions, or reasoning.	**Analyzing Skills** • Identifying Attributes and Components • Identifying Relationships and Patterns • Identifying Main Ideas • Identifying Errors	Adjusting paper plane shape and weight and launcher angle and force, students analyze the relationship between these variables and the distance the paper plane will fly.
Generating Skills involve using the students' prior knowledge to add information beyond what is given. Connections between new ideas and prior knowledge are made as new information and ideas are recast into new structures.	**Generating Skills** • Inferring • Predicting • Elaborating	By using the information they have collected, students can predict the distance a paper plane will travel before conducting their next experiment.
Integrating Skills involve putting together the relevant parts or aspects of a solution, understanding, principle, or composition and incorporating this integrated information into a new understanding.	**Integrating Skills** • Summarizing • Restructuring	In the **Practice Flight** program, students design experiments to test the influence of each variable and repeat experiments as often as desired in order to collect enough data to find methods of predicting their results. The knowledge and understanding gained from **Practice Flight** is applied in **Challenge Flight**.
Evaluating Skills involve assessing the reasonableness and quality of ideas.	**Evaluating Skills** • Establishing Criteria • Verifying	Students predict the distance a paper plane will travel based on the data they have collected and evaluated. A good understanding of the interplay among the four variables will allow students to create a plane that will hit the target distance in **Challenge Flight**.

PAPER PLANE PILOT STUDENT HANDOUTS

On the following pages are the student handouts mentioned in the "Use in an Instructional Setting" section (pages 18-19). Each handout is briefly described below.

Handout 1a: Introducing the *Paper Plane Pilot* Variables (English Measurement)
Handout 1b: Introducing the *Paper Plane Pilot* Variables (Metric Measurement)

This handout introduces the four variables and the functions of each and states the conditions each variable includes.

Handout 2: Meet and Match

With this handout, students will become familiar with the variables used in ***Paper Plane Pilot*** by matching each variable icon with what it means and what it does.

Handout 3: Practice Sheet

This handout is designed to familiarize students with the process of recording variable conditions and test results during a demonstration of **Practice Flight.**

Handout 4: Data Recording Sheet

This handout is designed for students to record the variable conditions and the results of their investigations while using **Practice Flight.**

Handout 5a: Data Graphing Sheet (English Measurement)
Handout 5b: Data Graphing Sheet (Metric Measurement)

This handout is designed for students to graphically record the distance results of their investigations while using **Practice Flight.**

Handout 6: Problem Recording Sheet

This handout allows students to record problem conditions, variable conditions, and trial results while using **Competition Flight.**

Handout 7a: What I Found Out (English Measurement)
Handout 7b: What I Found Out (Metric Measurement)

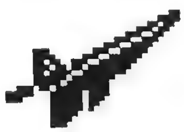
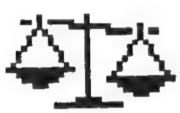
This handout helps students summarize their conclusions.

1a

Introducing the *Paper Plane Pilot* Variables

(English Measurement)

Name ____________________

PAPER PLANE		The **plane** represents the three plane **shapes**.	 X-10	 X-20	 X-30
		The **scale** represents the three possible plane **weights**.	 1 ounce	 2 ounces	 3 ounce
LAUNCHER		The **launcher** represents the three launcher **angles**.	 10°	 20°	 30°
		The **hand** represents the three launcher **forces**. (Think of pulling back on a rubber band.)	 1	 2	 3

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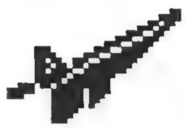
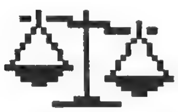
1b

Introducing the *Paper Plane Pilot* Variables

(Metric Measurement)

Name ____________________

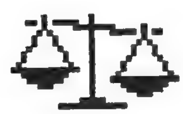
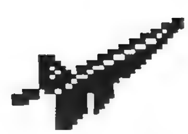
PAPER PLANE		The **plane** represents the three plane **shapes**.  X-10  X-20  X-30
		The **scale** represents the three possible plane **weights**.  28 grams  57 grams  85 grams
LAUNCHER		The **launcher** represents the three launcher **angles**.  10°  20°  30°
		The **hand** represents the three launcher **forces**. (Think of pulling back on a rubber band.)  1  2  3

2

Meet and Match

Name ______________________

Draw a line to connect each variable symbol with what it means and what it does.

What the Variable Means	Variable Symbol	What the Variable Does
Weight		Gives three choices of plane shapes.
Angle		Presents three launcher forces.
Force		Gives three launcher angles.
Shape		Presents three plane weights.

3

Practice Sheet

Name ______________________

	Plane Variables		Launcher Variables		
Trial	Shape	Weight	Angle	Force	Distance

4

Data Recording Sheet

Name ____________________________

Use this chart to record your results from **Practice Flight.**

	Plane Variables		Launcher Variables		
Trial	Shape	Weight	Angle	Force	Distance

5a

Data Graphing Sheet

(English Measurement)

Name ____________________________

Graph your distance results from the **Practice Flight** trials.

Trial	Distance	0 5 10 15 20 25 30 35 40 feet
Example	32.7	

mecc

Data Graphing Sheet
(Metric Measurement)

Name ____________________________

Graph your distance results from the **Practice Flight** trials.

Trial	Distance	0 2 4 6 8 10 12 meters
Example	10.7	

6

Challenge Recording Sheet

Name ____________________________

Challenge Level: ______________
Goal: ________________________
Pre-Set Variable: ______________

Trial	Shape	Weight	Angle	Force	Distance
1					
2					
3					

Challenge Level: ______________
Goal: ________________________
Pre-Set Variable: ______________

Trial	Shape	Weight	Angle	Force	Distance
1					
2					
3					

7a

What I Found Out

(English Measurement)

Name ______________________

For each variable shown below, circle the setting that makes the plane fly farthest. Be ready to show how the data you collected agrees with your answers.

Shape	X-10	X-20	X-30
Weight	1 ounce	2 ounces	3 ounces
Angle	10°	20°	30°
Force	1	2	3

Imagine that you have set all the variables and flown your plane. Now you will make some changes. Predict the result of each change and cross out one of the bold words so that each statement is correct.

1. You make the plane heavier. The new distance will be **greater** **less** than the first flight.

2. You make the angle of the launcher smaller. This time the plane will fly a **further** **shorter** distance than the first flight.

3. You adjust the force by making it greater. This will **increase** **decrease** the distance the plane flies.

7b

What I Found Out

(Metric Measurement)

Name ______________________________

For each variable shown below, circle the setting that makes the plane fly farthest. Be ready to show how the data you collected agrees with your answers.

Shape	X-10	X-20	X-30
Weight	28 grams	57 grams	85 grams
Angle	10°	20°	30°
Force	1	2	3

Imagine that you have set all the variables and flown your plane. Now you will make some changes. Predict the result of each change and cross out one of the bold words so that each statement is correct.

1. You make the plane heavier. The new distance will be **greater** **less** than the first flight.

2. You make the angle of the launcher smaller. This time the plane will fly a **further** **shorter** distance than the first flight.

3. You adjust the force by making it greater. This will **increase** **decrease** the distance the plane flies.

LAB ACTIVITY HANDOUTS

Actual lab activities and experiments can be conducted in the classroom to demonstrate, reinforce, and expand on the experiments simulated in ***Paper Plane Pilot***. Included are a few lab activities and instructions for their use. These can be demonstrated to the class or conducted by the students individually or in groups.

Lab Handout A1: Build a Paper Plane

This handout gives step-by-step instructions for constructing a simple paper plane.

Lab Handout A2: Try These Changes . . .

This handout introduces students to some changes they can make to their paper planes to make them fly farther than usual, change direction, and even roll.

Lab Handout B1 and B2: Build a Canard

These handouts give instructions for building and assembling a plane with both a wing and an elevator.

Lab Handout C1 and C2: A Delta Wing

These handouts give instructions for constructing a Delta wing.

Note: When the tabs are bent up, the plane should fly up. When the cut tabs are bent down, the plane should fly down. When the tabs are bent up on one side and bent down on the other, the plane should roll in the direction of the bent-up tab.

Lab Handout D: Build a Cylindrical Wing

This handout give directions for constructing a cylindrical wing.

Note: If the weighted fold is at the rear of the wing, performance is poor.
If the wing has weighted folds at both ends, performance is poor.
If the wing is built without a ridge, but weighted with a band of aluminum foil, the performance is good.

Lab Handout E1 and E2: Build a Biplane

These handouts present a pattern for a biplane as well as step-by-step instructions for assembling the plane.

Lab Handout F: Can You Do This?

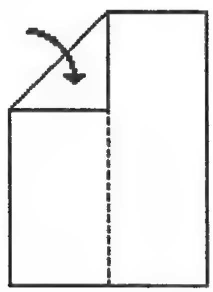
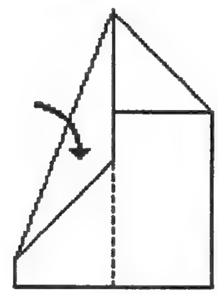
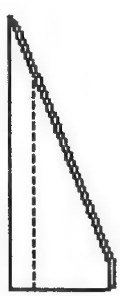
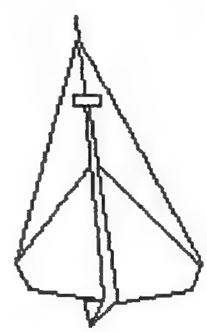
This handout challenges students to create paper planes that satisfy various conditions.

A1

Build a Paper Plane

Follow these steps to construct a paper plane. Make sure the folds are straight. For best results, run your fingernail along the folds to make sharp creases.

Things you will need: paper, tape, paper clip, scissors, and pencil.

1  Fold a sheet of paper the size of this page in half. Unfold the paper and smooth it out. Now fold in each corner. The inside edges should line up with the center crease.	2  Fold each side of the plane to the center as shown. The inside edges should line up with the center crease.
3  Fold the plane in half by bringing the wings together. Measure up 1" from the bottom edge and draw a straight line. Do the same on the other side of the plane.	4  Fold the wings down along the straight lines you drew in step 3. Make sharp creases and then open the fold. Finally, put a piece of tape tightly across the top so the wings pull together.

Try These Changes . . .

Extra distance

To keep the plane from wobbling, add a paper clip near the center of the plane. The extra weight will also help the plane fly farther. If the plane climbs too quickly, move the paper clip forward. If the plane nose-dives, move the paper clip back a little. Try moving the paper clip to different positions and see what happens to the flight of the plane.

Add a roll

Fold the edge of one wing up and fold the edge of the other wing down. Now your plane should roll over as it flies.

Climb and dive

Make two small cuts in the back edge of each wing to form tabs. The cuts should be 1 1/2 inches apart. Try bending the tabs at different angles. To make the plane climb, bend them up. To make the plane dive, bend them down. Bend the tabs up slightly and watch what happens on a long flight.

Change direction

Fold the outer edges of the wings up and make a small cut along the new fold in the end of each wing. The cuts form a rudder on each side, which can make your plane head left or right. Fold both rudders slightly to the left and see what happens. Then fold both of them to the right.

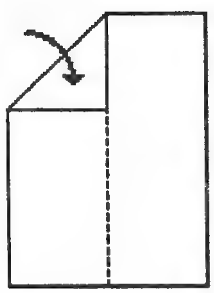
Build a Canard

B1

The first planes flown by the Wright brothers were canards. The plane is designed with an elevator in front and is known for its long straight flights with slow descent. Follow these instructions to build your own canard.

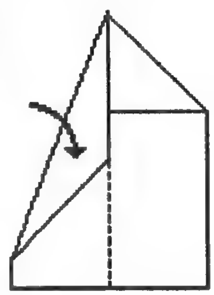
The Wing

1



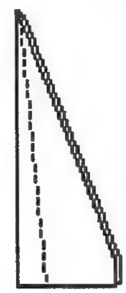
Fold an 8 1/2" x 11" piece of paper in half. Unfold the paper. Fold in each of the corners in to the center crease.

2



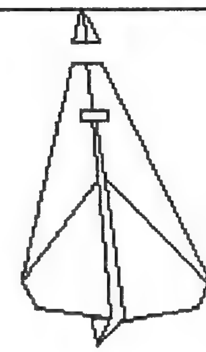
Fold each side of the plane in to the center as shown. The inside edges should line up with the center crease.

3



Fold the plane in half, bringing the wings together. Measure up 1 1/8" and draw a line to the tip of the wing. Do the same on the other side.

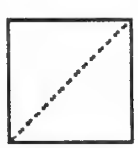
4



Fold the wings down along the lines you drew in Step 3. Make sharp creases and then open the fold. Cut off the nose 1.25" from the tip.

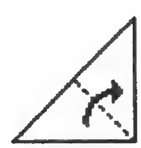
The Elevator

5



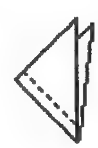
Cut a 5" x 5" piece of paper. Draw a line from corner to corner. Cut the square along this line. Discard one of the pieces.

6



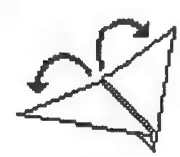
Fold the triangular piece in half to form a smaller triangle.

7



Measure up 3/8" from the folded edge and draw a straight line. Do the same on the other side.

8

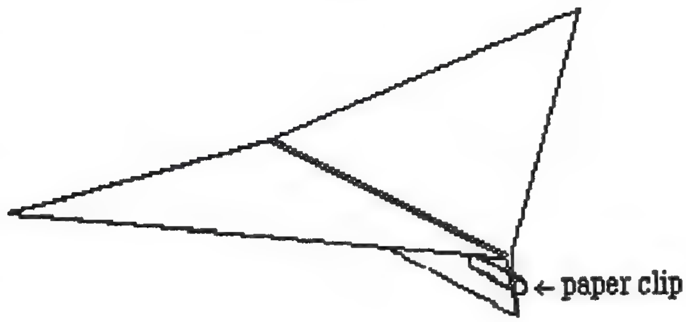


Fold the wings down along the lines you drew in step 7. Make sharp creases and then open the fold.

Build a Canard

B2

Assembly

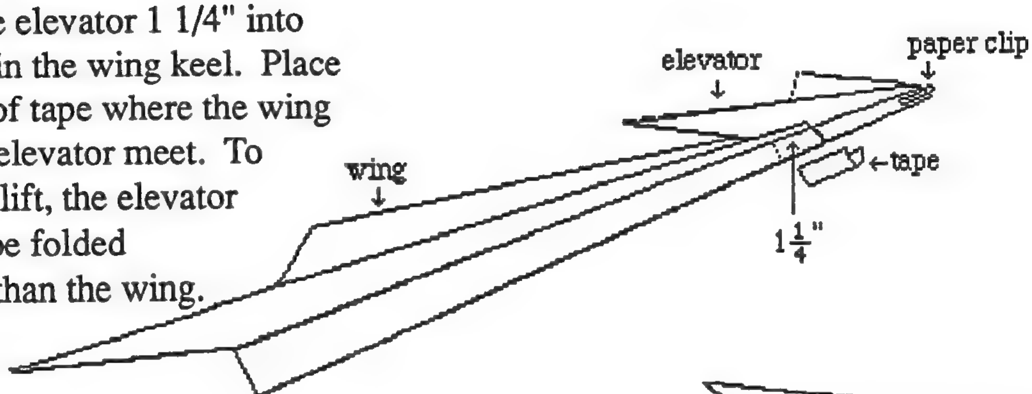


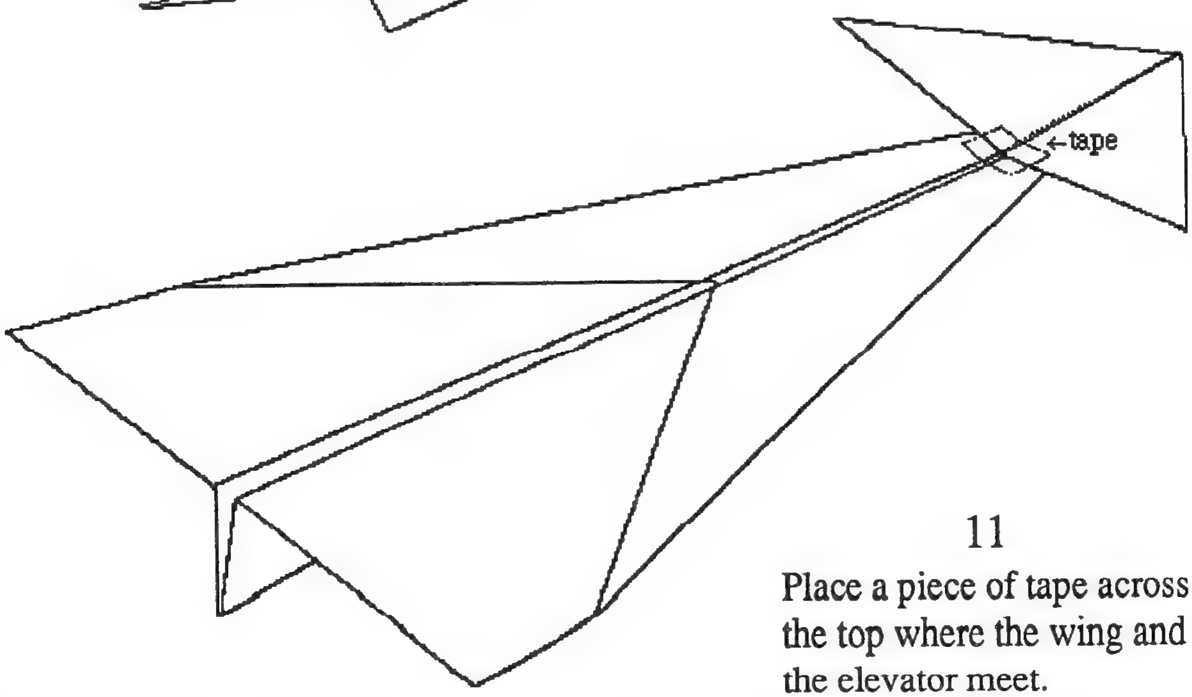
9

Slide a paper clip onto the nose of the elevator.

10

Slide the elevator 1 1/4" into the slot in the wing keel. Place a piece of tape where the wing and the elevator meet. To provide lift, the elevator should be folded steeper than the wing.





11

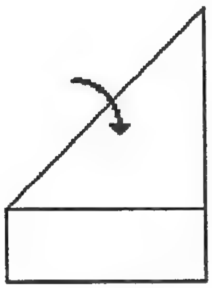
Place a piece of tape across the top where the wing and the elevator meet.

A Delta Wing

C1

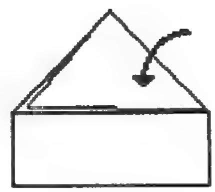
Follow these steps to construct a Delta wing. Make sure the folds are straight. For best results, run your fingernail along the folds to make sharp creases.

1



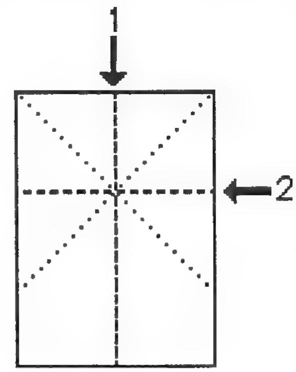
Use an 8 1/2" by 11" sheet of paper. Fold the top-left corner down so that the edges of the paper line up.

2



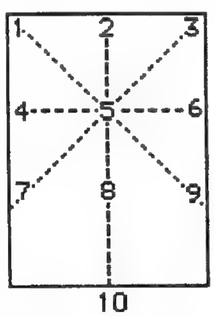
Fold the top-right corner down to touch the other side of the paper. Your paper should look like the picture above.

3



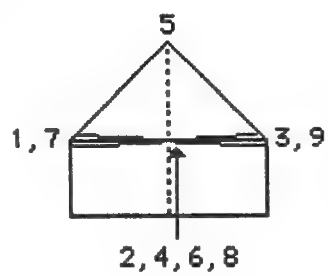
Unfold the paper. Following line 1 in the picture above, fold the paper in half the long way. Follow line 2 and fold the paper down.

4



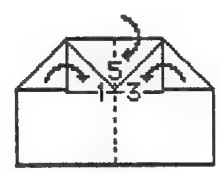
Unfold the paper and smooth it out. With a pencil, mark the numbers 1 through 10 on your paper as shown.

5



This step is tricky. Bring point 4 to point 8; bring point 1 back to point 7; and bring point 6 to point 8. Then bring point 3 to point 9. (This will also bring point 2 to point 8.)

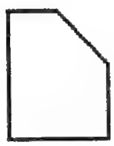
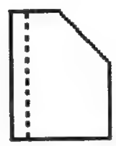
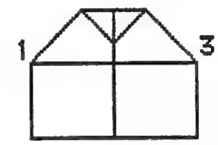
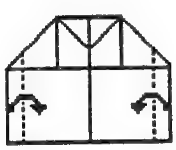
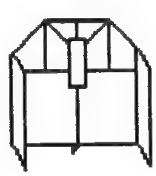
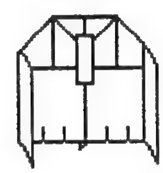
6



Fold the top (point 5) down to point 8. Fold points 1 and 3 in towards the center. All three points (1, 3, and 5) should be touching.

A Delta Wing

C2

7  Fold the paper in half along the center fold.	8  Measure up 3/4" and draw a straight line. Flip the paper over and do the same on the other side.	9  Fold the wings down along the lines you drew in step 8. Make sharp creases and then open the folds.
10  Fold the wing edges up 1/2".	11  Place a piece of tape long the center of the plane. This will hold the wings together.	12  On each half of the plane, cut three 1/4" slits along the back. On both sides make one of the slits along the fold in the wing. These slits will create four tabs.

Fly your plane. If it needs more weight, add a paper clip to the front.

Fly the airplane once with the cut tabs bent up. Fly it again with the tabs bent down. How were the flights different?

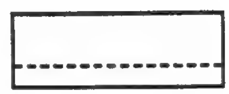
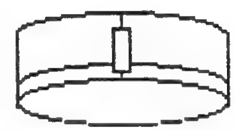
Fly the plane with one tab bent up and one tab bent down. What happens?

D

Build a Cylindrical Wing

Follow these instructions to make a cylindrical wing. Be careful to make straight folds and sharp creases.

You will need: 1 piece of paper, a pencil, a ruler, and tape.

		
Start with a 8 1/2" x 11" piece of paper. Measure up 1/2" and draw a straight line across the paper. Fold the paper up along the line.	Continue folding up until the paper measures about 2 1/2" from top to bottom.	Now curve the paper so you form a cylinder with an 11" circumference. Overlap the edges of the paper slightly and tape along the seam.

Cup the plane in your hand with the weighted end forward. Launch the wing by gently pushing it upward and forward.

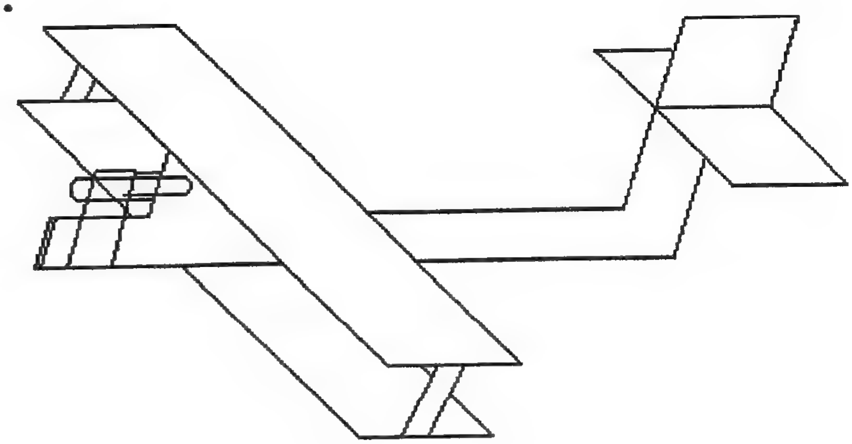
What happens if . . .

- The weighted fold is at the rear of the wing when it is launched?
- You construct a wing with weighted folds at both ends?
- What happens if there are no folds in either end of the wing, but you weight one end with a band of aluminum foil?

Build a Biplane

E1

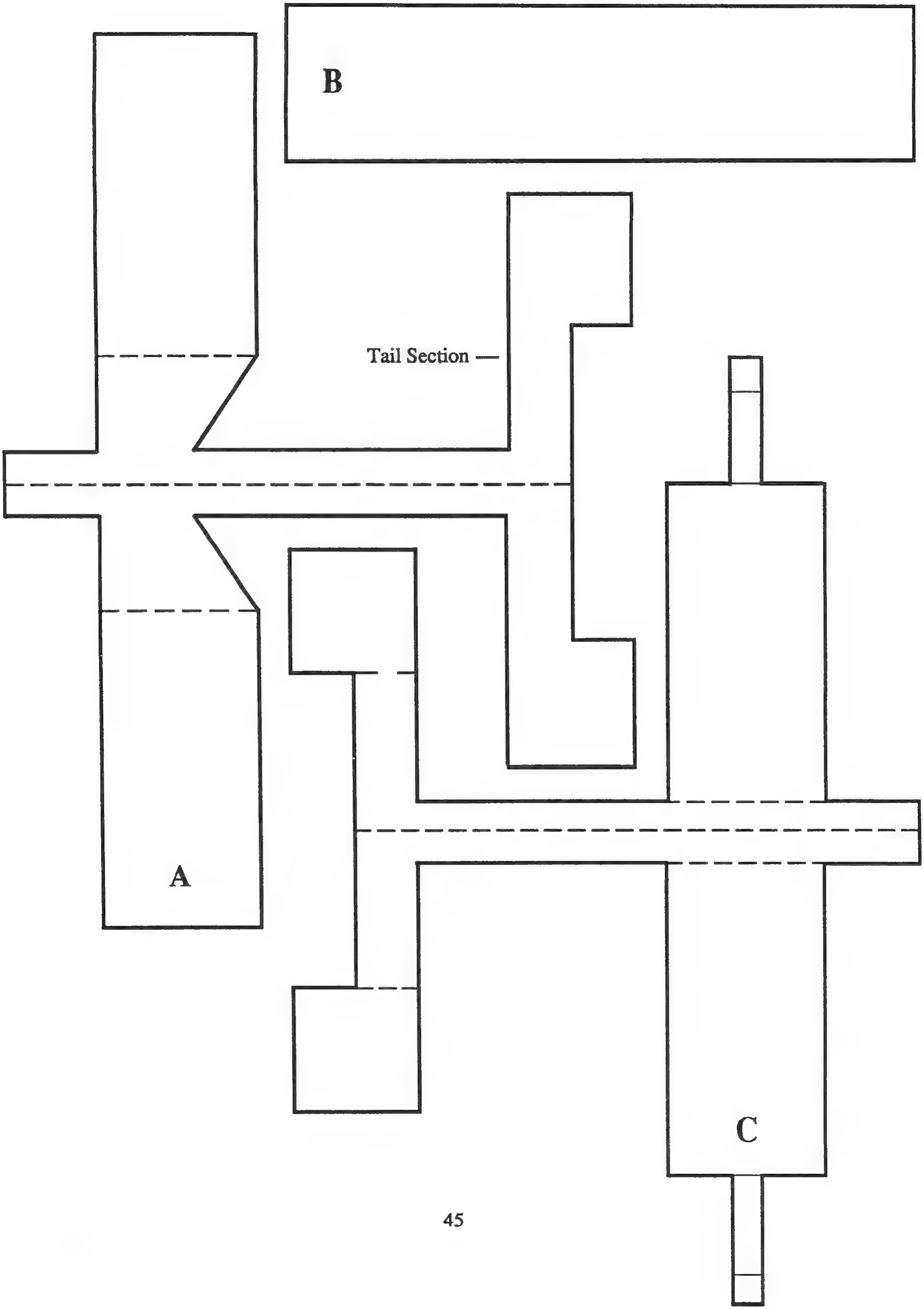
THINGS YOU'LL NEED:



glue
tape
scissors
stiff paper
plane pattern
1 large paper clip
crayons or markers

DIRECTIONS:

1. Cut out each piece of the pattern found on the next page.
2. Paste each piece carefully and smoothly onto a stiff piece of paper. This will make the plane sturdy. Cut out each piece.
3. With crayons or markers, decorate Part **B** and the tail sections of Part **A**.
4. Take Part **A**. Fold in half along the long dotted line so you have a high cockpit area. The letter **A** should be on the outside. Next, fold the wings down on the dotted lines. The letter **A** should be on the underneath side of the wing. Glue the two halves of the fuselage and tail together.
5. Glue Part **B** to the upper surface of the wing to make it stronger.
6. Fold Part **C** along dotted lines so that the letter **C** is on the inside. Then fold the wings down so the letter **C** is on the top side of the wing. Fold the two tail pieces down.
6. Coat the inside of the fuselage and the vertical part of the tail of Part **C** with glue. Insert the fuselage of Part **A** into the fuselage of Part **C**—be careful to keep the ends of the two parts even—and squeeze them to glue together.
7. Fold the long tabs on the ends of the lower wings on Part **C** up to meet the upper wings on Part **A**. Fold the short tabs over and glue them to the underside of the upper wing.
8. The plane is almost done, but it won't fly until it's balanced. Slip the paper clip onto the piece between the upper and lower wings. Slide it back and forth until the plane flies well. When you have found the best position, tape it in place.


B
Tail Section
A
C

F

Can You Do This?

Using what you know, see if you can construct a plane that will fly at least ten feet under the following conditions. Make a plane:

- from a full sheet of the daily newspaper
- from a paper towel
- with no folds in it
- with a wingspan wider than the length of the plane
- that weighs the same as a new #2 pencil
- that will carry the weight of eight paper clips
- from five things in your desk
- that will fly backwards as well as forwards
- with only one wing
- from balsa wood and tissue paper
- that will carry a replica of itself
- that will pull a 6" x 1/2" banner with your name on it
- that performs a 360° horizontal roll in flight
- that perform a 360° vertical loop in flight

BACKGROUND INFORMATION

The ***Paper Plane Pilot*** model is based on data collected from actual investigations with a launcher and paper planes. The investigations were conducted indoors to minimize the effect of air flow. The planes were constructed from contact paper and the weight was increased by adding cardboard beneath the wings. The designs for the planes were taken from *30 Planes for The Paper Pilot* (Vollheim, 1985). The launcher consisted of a meter stick with a rubber band pulled to three specific lengths to simulate the three forces. The meter stick was raised to three distinct heights to indicate angle. During these investigations, three different planes were tested with each combination of the experimental variables: plane weight, launcher angle, and launcher force.

The supporting algorithms for the instructional programs are based on an analysis of the data collected and also on established theories of motion from physical science. The algorithm for the events in ***Paper Plane Pilot*** are based on the following generalities.

With all other variables remaining constant,

- the greater the force, the further the distance;
- the smaller the angle, the further the distance;
- the lighter the plane, the further the distance.

Every effort was made to make this model simulate reality. You should not, however, expect that student data collected from classroom investigations will be the same as that collected in ***Paper Plane Pilot***. As with all models, the ***Paper Plane Pilot*** model is greatly simplified compared to the complexities of the real set of events being modeled. Models are, in fact, deliberately simplified to provide a greater opportunity to study and to understand systems that are ordinarily complex sets of cause-and-effect relationships. An interesting follow-up activity for your classroom might be to identify as many of these limitations as possible and to discuss their impact on the reality of the model. A partial list of model assumptions includes:

- Paper planes always fly in a straight line.
- The planes' flights are not aided or hampered by a breeze or wind.
- Distances are consistently measured to the point the plane touched down.
- Planes have not been damaged in previous flights.
- The launcher exerts consistent force for a given setting.

TEXTBOOK CORRELATION

Paper Plane Pilot is designed to be directly integrated into your normal elementary science lessons. The following charts correlate the instructional objectives and processes of ***Paper Plane Pilot*** with specific chapters and units in five popular elementary textbook series: Addison-Wesley; Holt, Rinehart and Winston; Merrill; Scott, Foresman; and Silver Burdett & Ginn. Also included are correlations for certain junior high level textbook series (Holt, Merrill, and Silver Burdett & Ginn). By referring to these charts, you can create lessons that directly relate to your classroom activities.

Addison-Wesley 1989

Grade	Chapter	Pages	Processes	Concepts
3	6	134-135	Observing Relating	Recognize that pushes and pulls are **forces**. Describe how forces are used to do **work**.
3	6	138-140	Observing Comparing	Recognize the effects of **gravity**. Describe the effects of **friction**.
4	5	110-111	Comparing Inferring	Describe **gravity**. Recognize **weight** as a consequence of gravity.
4	5	114-115	Observing Relating	Describe **metric units** of measurement of distance and volume.
5	8	186-189	Observing Comparing Relating	Describe the term **motion**. Distinguish between **speed** and **acceleration**.
5	8	191-195	Observing Relating	Interpret the **laws of motion** and recognize examples of each law.
5	8	196-201	Comparing Relating	Compare **gravity** and **friction**. Describe the factors that affect the pull of gravity.

Holt, Rinehart and Winston 1989

Grade	Chapter	Pages	Processes	Concepts
4	1	206-207	Observing Comparing Relating	Explain how **force** is measured, how force is related to **work**, and what happens when a force is applied to an object.
6	1	12-17	Observing Inferring	Describe and measure **motion.**
6	1	24-29	Observing Relating	Describe how **mass** and **force** affect **accelerated motion.**
6	2	34-38	Observing Relating	Explain how **forces act in pairs** and how both forces affect objects.
6	2	39-46	Observing Relating	Describe how **gravity** and **friction** affect objects.
6	2	47-53	Observing Comparing Relating	Identify **balanced** and **unbalanced forces** that act on an airplane. Describe the parts of an airplane and how they control speed and direction.
6	2	48	Communicating	**Activity**—Study the history of flight.
6	2	51	Communicating	**Activity**—Research the controversy surrounding commercial airplanes that fly faster than the speed of sound.
6	2	51	Observing Inferring	**Activity**—How can you control the flight of a paper plane?
6	3	61-67	Observing Comparing Relating	Describe the **energy of objects** at rest and the energy of objects in motion. Describe how energy changes forms.

TEXTBOOK CORRELATION (continued)

Merrill 1989

Grade	Chapter	Pages	Processes	Concepts
3	7	119-212	Observing	Define **force** as a push or pull.
3	7	122-125	Observing Relating	Define **gravity** and give examples of its effects. Define **friction** and give examples of its effects.
4	3	45-51	Observing	List the steps of one **scientific method.**
4	3	58-59	Comparing Observing	Define **mass** and **weight** and explain how they differ.
5	12	223-227	Observing Relating	Define **position** and **motion.** Explain **friction** and describe how it can be helpful as well as a problem.
5	12	228-231	Observing Relating	Identify common **forces** and explain how many forces are used.
5	12	232-237	Observing Relating Inferring	Explain and give examples of **Newton's three laws of motion.** Define **acceleration.** Infer that motion occurs only if there is a net force acting on an object.
5	16	307-311	Observing Relating	Define and explain **energy.** Explain and give examples of **kinetic** and **potential** energy.

TEXTBOOK CORRELATION (continued)

Scott, Foresman 1989

Grade	Chapter	Pages	Processes	Concepts
3	6	116-117	Observing Comparing	**Force** makes objects move. Force relates to **gravity** and **friction**.
3	6	118-119	Observing Comparing	**Activity**—Use rubber band-powered toy airplanes to compare how additional weight affects distance.
3	7	138-139	Observing Comparing Classifying	**Energy** comes in different forms. **Motion** is a form of energy.
3	7	159	Observing Comparing Organizing	**Activity**—Does throwing a paper plane from different points change the distance it will travel?
4	6	140-141	Observing Comparing	A **force** is a push or pull that changes an object's speed, direction, or both.
4	6	150-151	Observing Comparing	Types of **energy—kinetic**, **potential**, and **mechanical**.
5	7	198-200	Observing Comparing	**Force** is an action that causes an object to change speed or direction.

TEXTBOOK CORRELATION (continued)

Silver Burdett & Ginn 1989

Grade	Chapter	Pages	Processes	Concepts
3	6	106-108	Observing Inferring	Describe a **force** as a push or pull. Conclude that a force is needed to cause a change in the motion of an object.
3	6	109-114	Observing Comparing Relating	Name three kinds of **forces.** Distinguish among **gravity, magnetism**, and **friction** as kinds of forces.
3	6	115-116	Observing Relating	Describe **work** as the product of force and distance.
3	6	117-119	Observing Relating	Describe **energy** as the ability to do work. Name five kinds of energy.
4	6	117-119	Observing Comparing Relating	Distinguish between **kinetic energy** and **potential energy.** Given examples of kinetic energy and potential energy.
6	5	112-114	Observing Comparing	Distinguish between **mass** and **weight.**

TEXTBOOK CORRELATION (continued)

The following correlations are for junior high school textbooks. The chapters listed in these correlations not only reinforce instructional material appropriate to ***Paper Plane Pilot***, but also extend into information beyond that covered by ***Paper Plane Pilot***.

Holt (Physical Science) 1986

Grade	Chapter	Pages	Processes	Concepts
7-9	1	8-13	Relating	Explain the steps of the **scientific method.** Describe what is meant by a controlled experiment.
7-9	1	16-24	Observing Comparing Relating	Explain why many scientific observations are made in the form of **measurements.** Use **metric units** to measure length, volume, mass, and temperature.
7-9	2	31-38	Observing Comparing Relating	Explain how you know when an object is in **motion.** Define **speed, velocity,** and **acceleration.**
7-9	2	39-46	Observing Comparing Relating	Describe how **forces** affect moving objects. Explain and give examples of **Newton's three laws of motion.**
7-9	2	47-51	Observing Comparing Relating	Show how to apply the **law of gravitation.** Describe how to measure the gravitational force acting upon an object. Compare **mass** and **weight.**
7-9	3	59-62	Observing Relating	Explain how a **force** can do **work.**
7-9	4	83-88	Observing Comparing Relating	Explain how **potential energy** is different from **kinetic energy.**

TEXTBOOK CORRELATION (continued)

Merrill (Physical Science) 1989

Grade	Chapter	Pages	Processes	Concepts
7-9	1	8-10	Observing Relating	Outline a **scientific method.** Define a scientific model.
7-9	2	25-38	Observing Comparing	Define a standard of **measurement**. Define **SI** and its major prefixes.
7-9	3	55-59	Observing Comparing Relating Inferring	Define **position** and **distance.** Define and distinguish among **rate, speed,** average speed, constant speed, and **velocity**.
7-9	3	66	Relating	Explain how changes in **velocity** are related to **force.**
7-9	3	66-69	Observing Relating	State and give examples of the **first law of motion.**
7-9	3	69-70	Observing Relating	Define **friction**, give examples of friction, and explain its effect on **velocity**.
7-9	3	70-72	Observing Comparing Relating	Differentiate between **weight** and **mass** and explain how weight and mass can vary. Explain how distance and mass affect the force of **gravity**.
7-9	3	73-74	Relating	Describe how **force** can be measured.
7-9	4	79-81	Observing Relating	Define **acceleration** and state the **second law of motion.**
7-9	4	86-87	Observing Comparing Relating	Define vertical and horizontal **velocity**.
7-9	4	91-94	Observing Relating	State Newton's **third law of motion** and cite examples. Distinguish between **action-reaction forces** and **accelerating forces** and identify each on a moving object.
7-9	5	101-104	Observing Comparing Relating	Define and give examples of **kinetic energy**. Define and give examples of **potential energy**. Discuss energy transfer in terms of **work**.

TEXTBOOK CORRELATION (continued)

Scott, Foresman (Physical Science) 1986

Grade	Chapter	Pages	Processes	Concepts
7-9	1	8-11	Observing Relating	Describe the **method scientists use to investigate** an idea.
7-9	1	12-16	Observing Relating	Describe the **International System of Measurement.**
7-9	2	24-27	Observing Comparing Relating	Define **motion** and explain its dependence on **frames of reference.** Distinguish between **distance** and **displacement.**
7-9	2	28-35	Observing Comparing	Distinguish between **speed** and **velocity** and explain their relationship relating to distance and time. Contrast speed and **accelerated motion.**
7-9	3	44-60	Observing Relating	Describe **Newton's three laws of motion.**
7-9	4	58-60	Observing Comparing Relating	Contrast **balanced** and **unbalanced forces.**
7-9	4	62-65	Observing Relating	Compare the three kinds of **friction.**
7-9	5	74-77	Observing Relating	Define the **acceleration** due to **gravity.**
7-9	5	78-81	Observing Comparing	Contrast **mass** and **weight.**
7-9	6	94-95	Observing Relating	Define **work** and state its unit of measurement.
7-9	7	112-113	Observing Relating	Describe the relationship between **work** and **energy.**
7-9	7	114-115	Observing Relating	Discuss how **kinetic energy** is related to **mass** and **velocity.**
7-9	7	116-119	Observing Comparing Relating	Explain **potential energy** and the meaning of the law of **conservation of energy.**

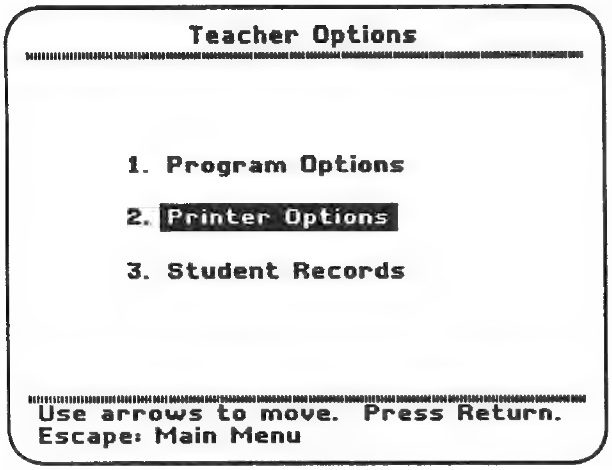
TEXTBOOK CORRELATION (continued)

Silver Burdett & Ginn (Physical Science) 1987

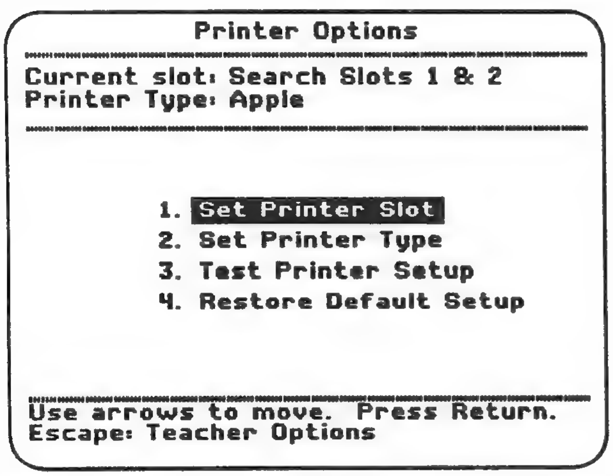
Grade	Chapter	Pages	Processes	Concepts
7-9	1	7-11	Observing Relating	Describe the **scientific method**.
7-9	1	12-18	Observing Inferring Relating	Explain the need for **standard measurements**. Name the units used to measure length, mass, temperature, and time.
7-9	12	280-285	Observing Comparing Relating	Identify different kinds of **forces**. Describe the effect of forces on an object.
7-9	12	286-289	Observing Relating	Describe the relationship between **gravity, mass**, and **weight**.
7-9	12	295-299	Observing Comparing Relating	Distinguish between **potential energy** and **kinetic energy**. Describe some forms of energy.
7-9	13	303-306	Observing	Define the term **work**.
7-9	14	329-333	Observing Comparing Relating	Distinguish between **speed** and **velocity**. Calculate the speed of a moving object. Distinguish between constant velocity and **acceleration**.
7-9	14	334-338	Observing Relating	State the **First Law of Motion**. Explain the relationship between mass, velocity, and momentum.
7-9	14	339-341	Observing Relating	State the **Second Law of Motion**. Relate the acceleration of an object to the force applied to the object and the mass of the object.
7-9	14	342-344	Observing Relating	State the **Third Law of Motion**. Identify the action force and the reaction force between two objects. Distinguish between a pair of balanced forces and a pair of action and reaction forces.

USING A PRINTER WITH THIS COURSEWARE

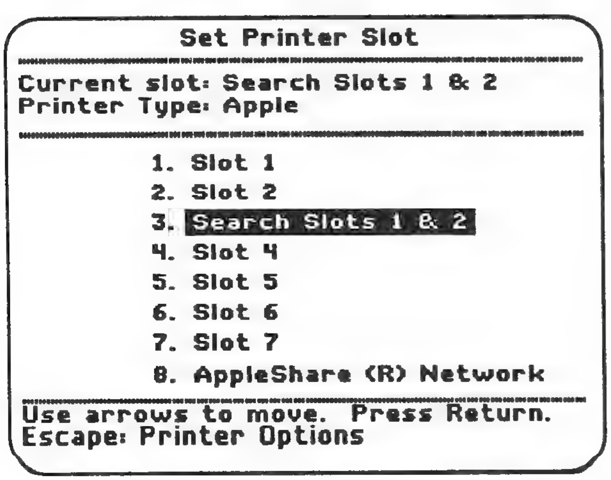
This product is initially set to work with a standard Apple printer card located in either Slot 1 or Slot 2. If you have this set-up, you do not need to do anything further. If you are connecting an Apple //c you must designate Slot 1 and use the computer's printer port. If your printer uses another setup, or to select or use special commands, use Printer Options.



Printer Options appears on the ***Paper Plane Pilot*** Teacher Options menu. You may access the Teacher Options from the main menu by typing Control-A.



From the ***Paper Plane Pilot*** Teacher Options menu, selecting Option 2 takes you to the Printer Options menu. The current printer settings are shown at the top of the screen.



Option 1, Set Printer Slot, allows you to specify the slot in which your printer interface card is located. If you are using an AppleShare® Network, choose option 8. This setting will automatically select the correct printer slot for each computer on the network.

```
              Set Printer Type
Current slot: Search Slots 1 & 2
Printer Type: Apple

            1. Apple Printer
            2. Epson Printer
            3. Special Configuration

Use arrows to move.  Press Return.
Escape: Printer Options
```

Option 2, Set Printer Type, allows you to select the type of printer you are using: either an Apple, an Epson, or a special configuration.

```
              Apple Printer
Current slot: Search Slots 1 & 2
Printer Type: Apple

          ✓ Default
            Semicondensed
            Condensed
            Boldface
            Add line feeds
            Suppress line feeds
            Slashed zeros
Arrows move, SPACE BAR to select.
Escape: Set Printer Type
```

Selecting **Apple Printer** allows you to choose one or more of the options shown in this screen.

You are not able to select both semi-condensed and condensed or add line feeds and suppress line feeds at the same time.

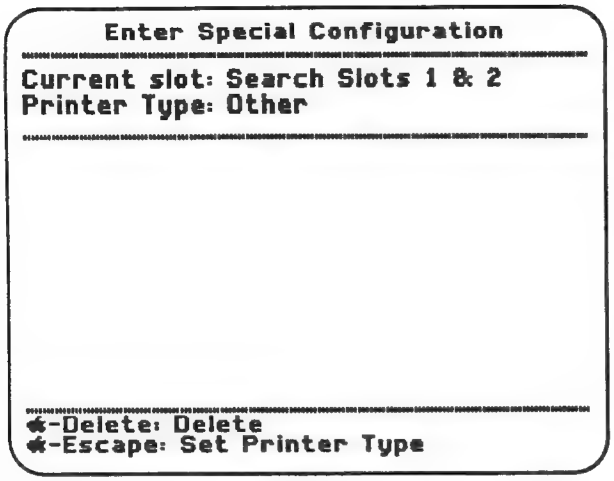
Selecting Default clears from the *program* all other customized options or special commands. To ensure that the *printer* clears all previous commands, turn the printer off, wait several seconds, and then turn it back on again before printing.

```
              Epson Printer
Current slot: Search Slots 1 & 2
Printer Type: Epson

          ✓ Default
            Compressed
            Italics
            Emphasized
            Double Strike

Arrows move, SPACE BAR to select.
Escape: Set Printer Type
```

Selecting **Epson Printer** allows you to choose one or more of the options shown in this screen.

You are not able to select both emphasized and compressed at the same time.

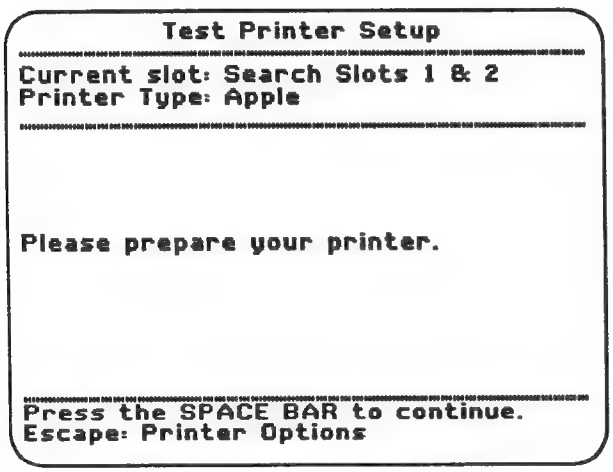
Selecting Default clears from the *program* all other customized options or special commands. To ensure that the *printer* clears all previous commands, turn the printer off, wait several seconds, and then turn it back on again before printing.



Selecting **Special Configuration** allows you to enter commands that enable certain types of printers to operate. These special commands are listed in the manufacturer's printer manual.

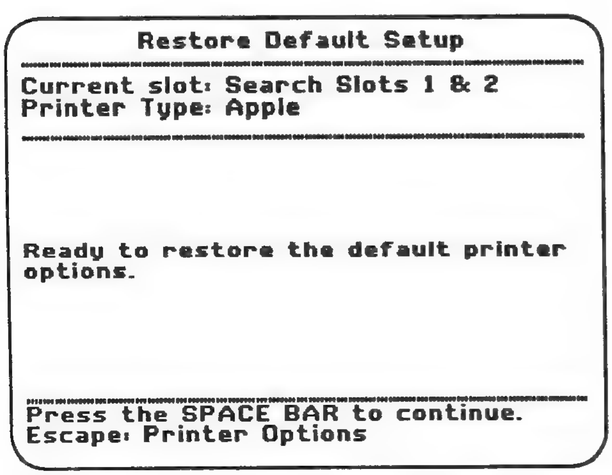
To enter special commands, type the exact characters required. When finished, type -Escape to end.

Do not set up the printer to use a proportional font. This setting will cause printed student records to be formatted incorrectly.



Option 3: Test Printer Setup prints out all of the keyboard characters. If these characters are not printed correctly, check the settings on your printer or interface card, check to see whether your printer has been connected correctly, or look at your interface card manual for special commands.

Note: To ensure that previous printer commands are cleared, turn the printer off, wait several seconds, and then turn it back on again before performing this test.



Option 4: Restore Default Setup returns all printer settings to their original state. The original printer setup provides a search of Slots 1 and 2 for a default Apple printer.

All changes made to the Printer Options settings are saved on the disk and are permanent until you use the Printer Options again to change the printer settings.

CREDITS

Paper Plane Pilot was produced by a MECC development team that included Beth Bell, Gene Breault, Mark Hanson, Diane Portner, Shari Zehm, and Steve Zehm, with additional assistance from the *Science Inquiry Collection* team.

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Mr. Paul Krocheski
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St. Paul, Minnesota

Mr. Steve Zehm
Fifth-grade students
Island Lake Elementary School
Shoreview, Minnesota

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TO THE READER:

MECC has made every effort to ensure the instructional and technical quality of this courseware package. Your comments—as user or reviewer—are valued and will be considered for inclusion in any future versions of the product. Please address comments to:

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Q. What exactly does the law say about copying software?

A. The law says that it is illegal to make or distribute copies of copyrighted material, including software, without authorization. If you do so, this is piracy, and you may face not only a civil suit, but also fines of up to $100,000 and jail terms of up to 5 years.

Q. So I'm never allowed to copy software for any reason?

A. If a backup copy was not included in the box with your original disk(s), you are permitted to make one copy in order to have both a working copy and a backup copy of the program. Copyright law prohibits you from making additional copies of the software for any other reason without the permission of the software company. If the publisher has authorized any exceptions to the copyright law, they will be stated in the license agreements that accompany all software products.

Q. But aren't schools allowed to make copies for educational purposes?

A. No. Like individuals and corporations, educational institutions are bound by the copyright law. Because of their unique position of influence, schools have a particular obligation to abide by the copyright law and educate students about their own responsibilities when using software. Just as it would be wrong to buy one textbook and photocopy it for use by many students, it is wrong for a school to duplicate software without the authorization of the publisher. This means that educators cannot make unauthorized copies for their students, either to use in school or to take home.

Q. At our school, we share programs all the time. We assume this must be okay, since the school purchased the software in the first place.

A. Many educators are not aware of how the copyright law applies to them. Without the publisher's authorization to make copies, your school needs to purchase as many copies of a program as you will use. However, many software firms do offer special sales arrangements to schools. These include reduced priced lab packs (a number of programs sold together) and site licenses (arrangements which permit schools to copy for a specific location at a fixed price). **Because these arrangements vary from publisher to publisher, it is essential that you read and understand the license agreement for each program before making any copies.**

Q. We're planning to install a network for our students. How do we know how many copies of software we'll need to purchase?

A. Remember that the installation of a network does not change your obligations with regard to the copyright law. When purchasing software for a network, be sure to ask the publisher what types of licensing arrangements are available for networks. Some software publishers allow schools to purchase a network license that authorizes the school to install stand-alone software on a network. In addition, many software publishers create special network versions that license the program to be run on the file server of a network. Because some publishers limit the number of workstations that are permitted to legally access the software on the network, it is very important to check the license agreement for any restrictions that may apply.

Q. I've read the license agreement for one of the software packages purchased by our school. What if I'm not sure that I understand the arrangement correctly?

A. If you have trouble understanding the license agreement, help is available. Your school district's media or computer specialist may be able to answer your questions. In addition, you can always contact the software publisher and ask for a clarification of the license agreement as it applies to your school. Finally, if you still have questions, contact the Software Publishers Association for more information about software and the copyright law.

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